British Hydroid Zoophytes.

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NOTES ON
BRITISH
HYDROID ZOOPHYTES
AND
OTHER SUBJECTS.

With Mrs Ruffords Compliments

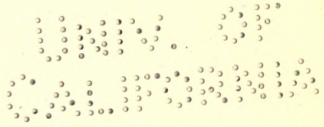

Photo by Window & Grove. *Baker Street, W.*

PHILIP JAMES RUFFORD, F.G.S.

NOTES ON

BRITISH

HYDROID ZOOPHYTES

AND OTHER SUBJECTS

(POLYZOAN CONCHOLOGICAL & GEOLOGICAL)

BY THE LATE

PHILIP JAMES RUFFORD

F.G.S.

Published by HIS WIFE

EDITED BY

Edward Connold, F.E.S.

Author of "British Vegetable Galls"

HASTINGS

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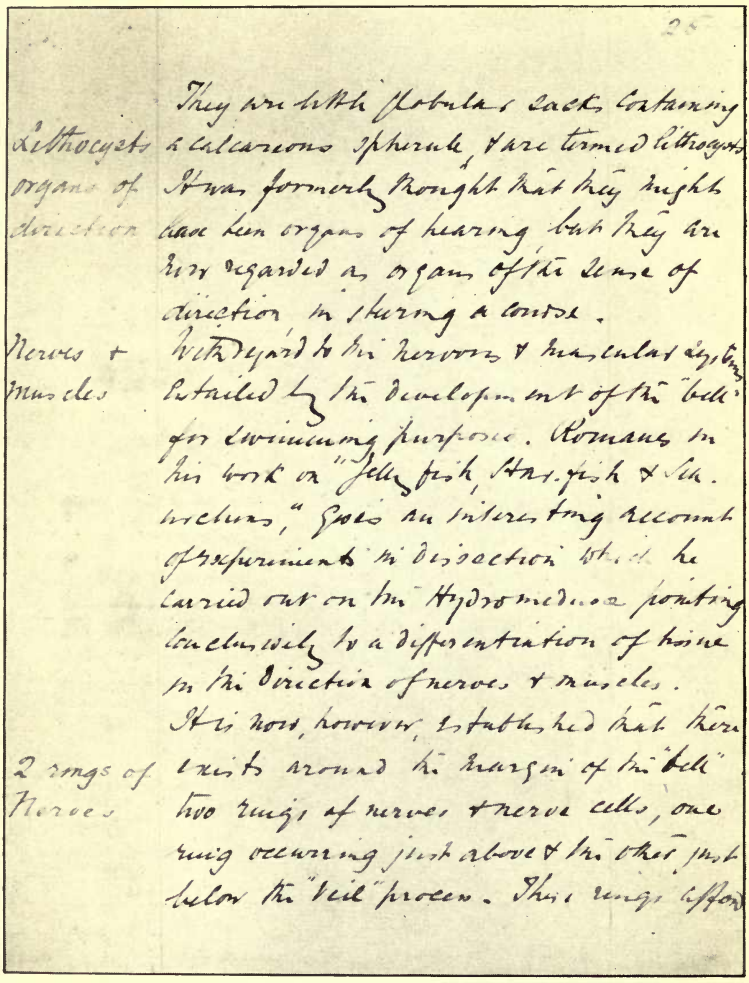

They are with globules each containing
Lithocysts organs of direction a calcareous spherule, & are termed lithocysts
It was formerly thought that they might
have been organs of hearing but they are
now regarded as organs of the sense of
direction in steering a course.
Nerves & muscles With regard to the nervous & muscular system
detailed by the development of the "bell"
for swimming purposes. Romanes in
his work on "Jelly fish, Star-fish & Sea-
worms," gives an interesting account
of experiments in dissection which he
carried out on the Hydromedusæ pointing
conclusively to a differentiation of tissue
in the direction of nerves & muscles.
He has however established that there
2 rings of Nerves exists around the margin of the "bell"
two rings of nerves & nerve cells, one
ring occurring just above & the other just
below the "veil" process. This rings after

E. C. *Photo.*

Folio 25 of
PHILIP JAMES RUFFORD'S MS.

See p. 20.

AUTHOR'S PREFACE.

The writer would like at the outset to acknowledge his great indebtedness to Hincks' work on the "Hydroid Zoophytes." He has, however, studied the local species sufficiently carefully in their haunts, and with the microscope, to enable him to write from personal observation.

The figures, except those ascribed to other authors, are from sketches from nature by the author.

The specimens in the Collection here described (unless otherwise stated) were presented to the Hastings and St. Leonards Museum, in 1899, by the Author.

P. J. Rufford.

October, 1899.

INTRODUCTORY REMARKS

BY

MRS. ALICE RUFFORD.

A short description may be desirable to acquaint the reader with the reason which has led me to publish this volume.

Some years ago it was resolved by the Committee of the Hastings Museum Association that the exhibits in the various sections should be catalogued. The Hon. Secretary, Mr. Crake, asked Mr. Rufford to begin by making a list of the specimens of the lower forms of Marine Fauna, giving a short description of each. This work he gladly undertook; but, finding it impossible to compress in a few words such a definition as would be of any use to a student, he produced the following illustrated catalogue which was acquired by the Association, by whom, but for lack of funds it would have been published. That I am now able to do so is owing to the generosity of the Committee in returning me the MS., and I offer them my sincere thanks for their courtesy.

I wish also to tender my hearty thanks to Mr. Connold, F.E.S., for undertaking the Editorship, contributing some pages, producing photographs for nineteen plates and relieving me of all care and anxiety; to Mr. Seward, F.R.S., for his sympathetic Appreciation, and to Dr. Woodward, F.R.S., who kindly obtained permission from the Trustees of the British Museum (South Kensington) to reproduce Plate XXI.; and lastly to Mr. Crake who constantly helped and encouraged Mr. Rufford in his work, for his kind contribution.

Knowing how strongly my late husband was imbued with the idea of the Educational value of Museums, I hope this little tribute to his memory will be found helpful to future students of the extremely beautiful and interesting Marine Fauna and Geology of Hastings.

ALICE RUFFORD.

37 MAGDALEN ROAD,

ST. LEONARDS-ON-SEA.

1902.

EDITOR'S NOTE.

It has afforded me a great amount of pleasure to edit this volume at the request of Mrs. Rufford, and I have endeavoured to arrange the material in as suitable a manner as possible.

For several years Mr. Rufford, and myself, collected the local Hydromedusæ and Polyzoa unknown to each other; and, while he studied the structure and economy of the creatures and their habitations, with the result shown in the following pages, my researches after a while were directed to other branches of Natural History.

Most of the illustrations represent the actual specimens collected by Mr. Rufford, three only are from my own collection; many more could have been added had it been thought desirable.

The objects depicted on Plates XII.-XVII. did not possess any other explanations than those which appear in the illustrations. I have therefore ventured to add several pages of descriptions, which, I trust will be useful.

Throughout the volume except pp. 123-129 the large type (Pica) represents Mr. Rufford's writing, the smaller type (Long Primer) that which has been added.

Edward Connold.

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(CORYNIDÆ).

Sub-order II. THECAPHORA.

Polypites provided with horny receptacles.

a Polypites stalked and terminal;
(CAMPANULARIIDÆ).

b Polypites disposed on both sides of axis;
(SERTULARIIDÆ).

c Polypites disposed of on one side only of axis;
(PLUMULARIIDÆ).

P. J. R.

NOTES ON THE WORK OF MR. P. J. RUFFORD FOR THE HASTINGS MUSEUM.

In putting these notes together I feel I am performing an urgent duty, the more pressing since during Mr. Rufford's life his innate modesty kept him ever in the background, so that for many years the part which he took in promoting the Hastings Museum was scarcely understood, and his name in Hastings unknown outside a small circle of fellow workers.

Mr. Rufford's first connection with the Museum was through the sale of the effects of the late Mr. S. H. Beckles, F.R.S., F.G.S., in April, 1891.

The Museum Committee was then fully organised, and a grant had been obtained from the Committee for the purchase of specimens. I was fortunate enough to accidentally meet Mr. Rufford—not knowing him even by name—and seeing him interested in the collection which he was explaining to a boy by his side, I came up and spoke to him. From this chance acquaintance a friendship sprang up between myself and Mr. Rufford, which was fruitful of so much during the last ten years for myself and the Museum. I shall always look with pleasure upon those days, at the same time regretting that they are ended.

To return to the Beckles' sale. I then mentioned the position of the Museum Committee as purchaser; and Mr. Rufford gladly consented to give me his advice as to what to purchase.

The Beckles' sale was an important step in the history of the Museum, because a home had to be found for the purchases. The Brassey Institute second floor was granted by the Town Council, and a beginning was made. In the minutes of April 2nd, 1892, I find a vote of thanks was passed to Mr. Rufford for his valuable aid in selecting fossils at the Beckles' sale, and again reference is made in the minutes of November 2nd, 1891, to expenses voted for removal of geological remains from Cliff End, Fairlight, to the Brassey Institute. This referred to the Iguanodon foot-print sand-cast now at the Museum which he presented.

In October, 1891, the Rev. J. W. Tottenham gave his munificent gift of his private Museum to the Museum, and after the removal which was carried out by me, Mr. Rufford threw himself vigorously into the task of arranging the specimens. Geology and Conchology and kindred forms of life had his peculiar care. Conchology was well represented in the Tottenham collection.

At an early stage of the history of the Museum, the Bradnam collection of local fossils from the Town Hall formed part of the original nucleus, to this was added the Beckles' fossils, mostly from the Wealden strata. A strong reinforcement was now to be added to our local collection by the loan of Mr. Rufford's private collection, which being added to from time to time, has given a marked geological character to the Museum, and caused it to be respected by geologists and men of science who visit the town.

At the opening of the Museum in the Brassey Institute, on Tuesday, August 16th, 1892, I made a few remarks from the platform in which after mentioning donors and lenders I said, "I must now turn to those who have given what is perhaps as valuable as money—that is time and dearly-bought knowledge. I must in the first place mention Mr. P. Rufford, our Hastings geologist, a gentleman well known in the scientific world for his researches amongst our Wealden flora; this gentleman has given up nearly his entire time since the month of May to arranging our specimens, both geological and otherwise. As I have been intimately associated with him during the last few months I can say that our Museum could scarcely have taken shape without his single-minded enthusiasm for science."

Mr. Smith Woodward, representing the Geological Department of the British Museum, referred to the discoveries of Messrs. Charles Dawson and Philip Rufford in the Wealden strata, and stated there was evidence that very soon their work would surpass that of Gideon Mantell, the great Sussex geologist.

On November 17th, 1893, Mr. Rufford was unanimously elected a member of the Museum Committee, from which time he became one of its most useful and energetic members, identifying himself thoroughly with its interests, and sparing neither time or trouble in any work he might set himself to accomplish.

The collection, including a fine series of Mollusca, was partly the cause that Mr. Rufford directed his attention to this section of Natural History, and to further illustrate the section many shells were added by him. The fishermen took to him specimens which were usually thrown back into the sea after the day's dredging, and by this means a fine collection of Hydroids and Polyzoa was formed, to which the energies of his later years were specially directed. At one time an effort was made to start Aquaria in the Museum. Mr. Rufford did his share of the work with ability, but the difficulty of keeping the water fresh marred his efforts in this direction. It is not necessary to detail the quiet work which Mr. Rufford carried out during the years between 1893 and 1899, making descriptive labels and displaying specimens; the Museum tells its own tale. But mention must be made of the pictorial work of illustration which he carried out during this period with prints gathered from the British Museum Catalogue of his Wealden flora at the British Museum, and other kindred sources. This was an improvement on the usual methods of labelling, and one much encouraged by the Committee. A recognition of Mr. Rufford's services was made by the Committee during this period by the gift of a standard work on shells which Mr. Rufford much appreciated.

In June, 1899, Mr. Rufford finally presented to the Committee the results of his labours. The letter was brief which announced the gift, it contained this passage:

> "Dear Crake,
>
> Thanks for your note, it may be well to specify the collections which I have the pleasure to offer to the Museum as a gift, *viz.*:
>
> 1. The Geological Collection from the Wealden formation of Hastings and neighbourhood at the Museum up to the present date.
> 2. Local recent Sponges.
> 3. Local Hydroids.
> 4. Local Echinoderms.
> 5. Local Polyzoa.
> 6. Local Mollusca.
> 7. Land and Freshwater Mollusca.
>
> (Local and from other Districts British.)"

We now approach the last years of this life full of study and joy in the search of the hidden secrets of the earth. Since 1899, Mr. Rufford had been engaged in

work for the Victoria History of the Counties of England, work for a Continental Museum, and in writing and illustrating the catalogues published in this volume, which is elsewhere referred to, also he was busy in the illustration of the Polyzoa and Hydroids to place with his specimens referred to in this volume. In the work of the removal of the collection into its new home on the first floor of the Brassey Institute in 1900, no member of the Committee worked harder than Mr. Rufford.

In 1901 the idea was mooted in the Committee of forming a Marine Biological Station in connection with the Museum, and money was voted for the purchase of a trawl net. This had Mr. Rufford's hearty support and during the winter of 1901, he paid a visit to the Marine Biological Station at Naples, purchasing specimens and himself studying on the spot, and visiting the fishing grounds in the steam trawl of the Institution; this resulted in an addition to the treasures of the Hastings Museum of Mediterranean Medusæ, etc.

Mr. Rufford heartily aided me with the work of demonstrations to schools, and one of his last remarks to me was, that he was very pleased with the boys and girls of Tower Road Board School who were so interested in his last lecture on Geology, as he feared that he had dealt with matters rather above them.

The loss to the Museum in the coming years will be great, as they will no longer have the willing aid of Mr. Rufford, one of its best friends, with his large scientific reading and experience which he was ever ready to place at the service of all, and whose place it will be difficult to fill, as such services can only be rendered by one who has been long in sympathetic touch with the Institution in all its aims and endeavours.

W. V. CRAKE,

Hon. Sec. of the

Hastings & St. Leonards Museum Association.

ST. LEONARDS-ON-SEA.

1902.

INTRODUCTION.

The Hydroids are mostly minute creatures and nearly all marine. The individual animal is termed a Polypite. They rank in organization just above the Sponges and below the Sea-anemones and Coral-polyps, to which they are closely allied.

Their structure is simple. A sack-like stomach, the only external aperture being the mouth, around which are arranged tentacles armed with poisonous darts or stinging cells, for the capture of prey.

The exterior of the body-wall is composed of a cellular layer (Ectoderm), some of the cells of which by extending and withdrawing lobes, perform the office of muscles, of which the Polypites proper are destitute. Within this is a delicate non-cellular membrane (Mesoglæa), the inner lining being composed of a layer of cells (Endoderm), which have the property of throwing out pseudopodia and flagella, by means of which circulation of the food particles is kept up. Some of these cells contain pigment and secrete a digestive fluid.

A very few Hydroids (ex. Hydra) lead a solitary existence. The great majority, however, by a plant-like process of continuous budding form colonies, the members of which are all organically connected, by reason of the

Buds or newly-formed Polypites not being detached. The connective parts are tubular, and allow the circulation of nutriment to all members of the colony.

In nearly all Hydroid colonies there is an outer horny cuticle (the Polypary), which in some cases does not clothe the Polypite itself, but only the connecting parts (the Cœnosarc). These naked Polypites form the division ATHECATA. Those in which the cuticle is prolonged to form protective cups or calycles constitute the division THECAPHORA.

The forms of the calycles vary, the rim being either plain, dentate, or with denticles which meet above the polypite and form a lid, or operculum.

The arrangement of the calycles on the stem and branches also differs. They may be either terminal (ex. *Campanularia*), biserial—opposite or alternate—(ex. *Sertularia*), or uniserial (exs. *S. Plumularia*, and *Antennularia*).

In one family of THECAPHORA there are found certain Amœboid bodies called Nematophores, more or less closely associated with the Polypites, and provided with darts and cuticular receptacles. The functions of these bodies are not known. It is possible that they are to be regarded as modified Polypites.

The principle of Alternation of Generation makes its first appearance in the Animal kingdom in this group. The Polypite is not

endowed with the function of sexual reproduction, but certain members produce *Special Buds* which are so endowed, the bearers of these buds becoming considerably modified in consequence. They are devoid of mouth or tentacles, and so do not concern themselves with procuring food. They are termed *Blastostyles*. The Special Reproductory Buds, in the lower forms of Hydroids, are liberated as Jelly-fishes, and disperse with their contained ova, to other parts. In the higher forms of Hydroids, these Reproductory Buds remain attached, setting free the ova *in situ*. Before liberation, the ovum undergoes segmentation, and produces, by a process of inversion, a central cavity—the future stomach. The embryo is termed a *Planule*, and is provided with cilia, by means of which it swims away, shortly attaches itself to some object, forms rootlets by the splitting up of the expanded base of attachment, and also develops a mouth and tentacles; it then becomes an ordinary Polypite, which, as growth proceeds, buds and forms a new colony.

P. J. R.

Fig. 1.

EXPLANATION OF FIG. 1.

Fig. 1. *Campanularia flexuosa*, Hincks.
(after Hincks.)

A. Natural size of colony.

B. A shoot enlarged, *bearing*

B.$^{/}$ Male reproductive capsules.

B.$^{//}$ Horny cup or receptacle.

B.$^{///}$ Polypite extended.

B.$^{////}$ Polypite retracted.

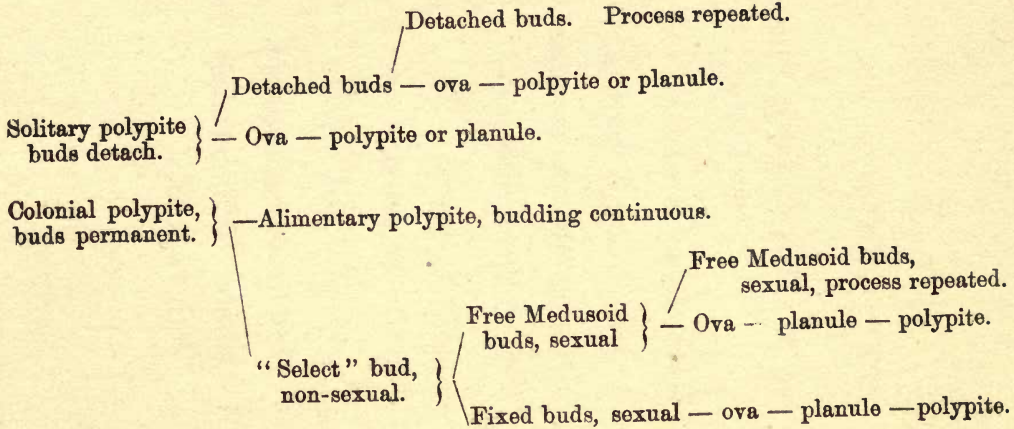
C. A shoot enlarged, *bearing*

C.$^{/}$ C.$^{/}$ Female or egg-capsules.

D. Cœnosarc, or connecting tissue which forms a tube.

TABLE B.

Showing the phases in reproduction (both by means of Budding and by Ova) in the solitary and in the colonial Hydroids.



P. J. R.

PART I.

THE ECONOMY

— OF —

BRITISH HYDROID ZOOPHYTES.

General Remarks. "Things of beauty are generally small," says Aristotle, and the animals here represented, taken individually, are generally so minute that they would probably escape the notice of even the most enthusiastic searcher, did they only occur singly. They, however, have the habit in one of the phases of their existence—the fixed phase—of living collectively or in colonies, and in this form they may be discovered without much difficulty, in rock pools along the sea-shore; growing amidst the groves and spinneys of seaweed, or upon rocks, seaweed, and shells; they are also carried about on the coverings of living shell-fish, upon the backs

of Crustacea, and, in fact, upon many other creatures and objects. The shrimp trawlers' nets and boats, and the "rubbish" from the larger trawling vessels afford a rich source whence many rare forms may be obtained.

Hydroids six-ft. high. If, however, we were to look abroad in the Pacific, we should find fixed hydroids of the stature of a man, that is five or six feet high, but those which we are likely to meet with here will generally require the aid of a microscope, in order that their beauty, structure, habits, and remarkable life history may be observed. They are, however, particularly convenient for the microscopist, since they are of so transparent a nature that their internal structure and the operations of digestion and circulation—not to mention the elaborate and interesting stinging apparatus, which the animals use for overcoming their prey—can be readily observed. Some knowledge of each step of the animal kingdom is so necessary as affording the key to other parts, and for a proper comprehension of the whole, that even creatures so low in the scale of organization as the present group, should not be despised.

If they require any testimonial to recommend them to lovers of nature, it will be sufficient to say that they are very closely allied to the sea-anemones and the polyps, animals which form those exquisite structures the Corals.

Hydroids allied to the Sponges and Corals. In organization, the Hydroid animals (or polypites) are a step below these; but, on the other hand, they have as neighbours below them, though in a separate order, the anomalous group of animals, the Sponges.

"Zoophytes," so named by Linnæus. The group with which we are dealing, in common with others of like form and habit, was styled by Linnæus "Zoophytes," since, in consequence of the peculiarity they evince of forming tree-like growths and of the resemblance of the animals themselves to flowers, he regarded them as combining the natures of both plants and animals.

The cause and nature of these structures will be found a most interesting study. The polypites themselves can hardly be excelled in chaste beauty, being usually of a crystalline transparency sometimes picked out with

opaque white, or occasionally coloured pink, red, or orange. In the free phase (Medusa) the colouring is more vivid. In form the polypites are particularly elegant, and have only to be seen in their native element under the microscope, when their graceful movements will elicit the utmost admiration. Sometimes they are suggestive of palm trees with the crown of leaves fully expanded and gently swaying in the air; but the illusion is often quickly dispelled by the sudden closing of the fancied leaves, and the animal nature is revealed in the efforts of the polypite to secure some minute prey. When the food has passed into the stomach, the polypite expands again to its original beauty.

Leaving the æsthetic side of the subject for a moment (in which there is ample scope for gratification), we will turn to the scientific and get some idea of the grade of organization which the Hydroids hold, more especially with reference to their near neighbours in the animal kingdom.

Structure of Polypite. The Polypites, in the typical and fixed phase of their existence, are of very simple structure, and

the organs may be very briefly enumerated, *viz.*: a mouth, a stomach, and arms or tentacles with which to grasp their prey.

Stinging apparatus. In addition, the tentacles are provided with stinging darts, by means of which the animals overcome the struggles of their victims. These darts are very intesting structures, consisting of sacks more or less oval in form, containing long, coiled-up tubes, which are shot out like harpoons and penetrate or adhere to the quarry, which may be a minute worm or crustacean. These dart sacks are formed within a single cell.

Darts poisonous. All experiments and observations concerning these darts tend to show that poison is infused into the victim.

Body and Stomach sack-like. The body of the polypite may be compared with a sack or bag, the tentacles being arranged around the mouth or body.

Body wall consists of an inner and outer layer of Cells, with intermediate Membrane, Non-cellular. The whole body wall, including tentacles, consists of an outer layer of cells ("ectoderm") and an

inner layer of cells ("endoderm"). The latter differ in character from the former, the endoderm cells being capable of throwing out and withdrawing lobular processes ("pseudopodia"), and also others which are lash-like ("flagella"). These two layers of cells are separated by a fine membrane which differs from the middle layer ("mesoderm") of the sponges, and other groups, in being non-cellular and having no structure. It is known as the ("mesoglœa").

No through alimentary Canal. From the sack-like nature of the body, it will be noted that there exists no through alimentary canal such as we find foreshadowed in the higher Cœlenterates, and well-marked in the Echinoderms. The base of the body of the animal is used for attachment, or, as a surface by which to crawl.

No Organs of Sight, etc. This description applies to the polypite phase only of the Hydroid career, in which stage sense organs (organs of sight, etc.) such as are found in another—the Medusa—phase are wanting, as also certain "pores" which subserve excretion.

Nerves and Muscles. As regards nervous and muscular systems. In the tentacles, branching nerve-cells are found at the base of the ectoderm cells immediately in connection with a layer of single unstriped muscle filaments which lie between the ectoderm and the fine membrane (mesoglœa), and, according to Parker and Haswell, are a derivative of the ectoderm, and may be regarded as a **Rudimentary Mesoderm.**

Colony-budding. Reference has been made to the peculiarity which specially characterises these Hydroids of forming groups or colonies, sometimes consisting of millions of creatures all in organic connection. These creatures, in common with many other of the lower animals, have the faculty of multiplying by means of budding, as it is termed. **Budding distinct from ova-production.** This method of reproduction is entirely distinct from that which takes place by means of ova, and may, perhaps, be tersely described as being produced by a simple inflation of the body wall **(budding an inflation of body wall)**; such inflation when perfected by the formation of a mouth

and tentacles, constitutes a new individual. These buds, in some few species (Hydra, etc.) become detached, and like their parents, lead a solitary existence (**solitary polypites**), but, they also, and far more frequently, remain permanently connected with the parent growth, and by continuous budding produce branching plant-like structures. (**colony budding**).

"Cœnosarc," or connective parts. Between the parent creature and the young bud there is generally a new piece of stem formed which serves as a connective part joining the bud to the main stem. Probably this arrangement enables the young bud the better to obtain sufficient space for its development, the expansion of the tentacles, and the procurement of food. These intermediate portions which connect the polypites, are termed the Cœnosarc (meaning common flesh).

Protective resemblance to seaweeds. So nearly do these growths resemble seaweeds that the majority of observers mistake them for seaweeds. This close resemblance may therefore very probably serve as a protection against their enemies which might show less

partiality for seaweed than for animal diet, and so leave them undisturbed. Or it may have this effect—that the unwary and desirable quarry upon which they feed can approach them without fear or misgiving. However this may be, the resemblance is so striking, that even the student may now and then be deceived.

Budding, common in lower animals. The process of throwing out buds, which become detached, is common to other low forms of life besides the hydroids; but this peculiar habit of continuous permanent budding is nowhere else carried to so high a degree, except in the nearly allied Coral polyps,* and the somewhat distant Polyzoa.

The Skeleton. The polypary. Hydroid animals, being of such an extremely delicate and slender nature, demand, like most other animals, some support and protection in the form of a skeleton, either internal or external. That which the hydroids have developed, is in the form of an external

*For the purpose of distinction the hydroid animal is termed a Polypite; the coral animal a Polyp; and the polyzoa a Polypide. Polyp meaning "many footed," and the terminations, ide and ite, "like."

tube or casing composed of a horny substance called **Chitine.** This casing forms a somewhat loose jacket, and clothes in the more simple forms (ATHECATA) only those stem-like and branching portions (Cœnosarc) of the animal structure. In a few exceptional cases the skeleton is of carbonate of lime. These little horny branching growths are frequently cast upon the beach in tangled masses with seaweed and other objects. On examination with a lens, it will be generally found that the tubes are empty, the animal part having become decomposed. The entire horny envelope of the colony is called the polypary.

Polypite receptacles. In the higher forms of hydroids (THECAPHORA) this covering is more fully developed, and is expanded so as to form receptacles for the polypites themselves. These receptacles take the form of chalices or elegant cups, often with deeply scalloped margins and ringed stems. Those with the ornamented margins bear a close resemblance to the delicate little flower, the Hare-bell, and they have consequently been named "Campanulariidæ."

Receptacle door, or lid. In some cases, amongst the higher kinds, there are devices for closing the top of the receptacle by a lid of various forms, which is forced open when the animal emerges, and closes when it retires. The lid is either external or internal, the latter form being the higher development.

"Nematophores." Attention should also be called to certain peculiar bodies called "Nematophores" or "Guard-polypites," which are found on the stem and branches of the *Plumulariidæ*, and often closely associated with the polypites. They have been carefully studied by Allman, and appear to be a prolongation of the outer animal layer of the cœnosarc, and show the lobular movements peculiar to the lowest form of animal life, *viz.*, the amœba. **(Amœba-like character of Nematophore).** They may be readily watched in either *Plumularia* or *Aglaophenia*. In the latter they are found exceptionally distributed over the egg-case. Their functions are not fully understood. In some instances dart sacks are found in connection with them.

Formation of Bud. It has already been mentioned that each member of the hydroid community is formed by what has been described as an inflation of the body wall, which consists only of an inner and an outer layer of cells, and an intermediate membrane.

Hollow connection between parent and bud. This statement implies that there is a hollow connection between the alimentary cavity of the parent and the new bud, which allows the nutriment elaborated by the parent to be conveyed to the young bud for its nourishment. (**Circulation of nutriment.**) This step is repeated with every bud formed, so that it will be understood that a regular circulation of nutriment previously prepared in the stomach of each polypite, can be continued throughout the whole colony, and utilized by those members requiring it.

Circulation maintained by "Cilia." Each individual can either pass it at will into the common channel, or can itself draw upon it. The current of this material, passing up

and down the tubes, is maintained by means of cilia—minute hair-like processes, which by constant waving keep up the circulation.

Object of circulation. It may be thought that this common supply is unnecessary, that each member could find ample food for itself. But there are the immature buds; the intermediate parts of the structure, that is, the cœnosarc, with the Nematophores; and, more important than all, certain other individuals yet to be described, which in consequence of special and important duties devolving upon them, are in many cases rendered incapable of obtaining food for themselves.

A brief description of these members of the colony will follow.

Dispersal. It will be evident that if multiplication of the individual be restricted to the method already described, (*viz.*, permanent budding), dispersal of the species could not take place. Nature has therefore allotted to certain individuals of the colony the duty of bearing other and special buds possessing the

power of reproduction by means of ova.* This order of reproduction is usually described as "Alternation of generation," and this is the earliest instance of its occurrence in the animal kingdom. It is very important to realize these steps, more especially as they are to a great extent obscured in many instances. We will therefore enumerate them thus :

The "Alimentary" polypite. 1.—Alimentary Polypite. The ordinary colonial polypite, whose only duty is to obtain and assimilate food for itself and the colony, but which takes no part in the work of propagation.

The "Select" polypite. 1A.†—"Select" Polypite. Certain of the above, which, for reasons stated in the foot-note, we

*It is extremely interesting to note the parallelism with this order in the plant world. For example: Amongst the Ferns (Cryptogams), if one of the spores found on the back of a frond be sown, the result will not be a fern, but a very small and simple plant—a leafy expansion, called a prothalium. It is the function of this little plant to produce the male and female elements; and so soon as fertilization has taken place it dies leaving the embryos ("oo-spheres") to develop into proper ferns.

†The "Gonoblast" idea of Huxley and the "fertile polypite" of Hincks. Some apology seems necessary for presuming to suggest a more suitable term for these Buds, in

have called the "Select" Polypites, generally more or less modified or atrophied, whose special function is to produce—not eggs, but special buds of either sex, which, in the case of the females, do produce eggs.

"Reproductive" bud. 2. — Reproductive Buds ("Gonophores"). Those special buds, whose main function is the reproduction of the species by means of ova.

Modification of "Select" polypite. The important duties imposed upon the select polypites have been instrumental in more or less considerably modifying their original character as alimentary polypites; so much so, that in many species they have lost the tentacles, and even the mouth and stomach, and have become mere stumps. (**Loss of tentacles, mouth and stomach.**) Under these circumstances, it will be seen how very necessary for its maintenance, and for that of

the face of such authorities as the above-mentioned. These terms appear, however, to mislead, since both expressions unquestionably imply the seed or ova-bearing Buds. Now these are not the seed or ova-bearing Buds, but polypites which bear those Buds. The term "Select," or Selected, is free from this signification, and at the same time distinguishes these Buds from the ordinary alimentary polypites.

its future progeny, is the common supply of nutriment which it can always obtain, and which is kept circulating through the connecting channels of the colony.

Division of labour. We have here, in this "select" polypite a primitive example of the principle of division of labour; all its energies, in many cases, being devoted to its special function, just as the various cells of which our bodies are composed have their particular characteristics and special duties.

Specialised individuals. Among the hydroid colony the specialisation of individuals is not confined to the example previously stated. There are others whose functions are not so clearly understood (Hydractinia). Reference will be made to these in the description of the specimens.

Sexes of "reproductive" buds. At certain seasons of the year these "select" polypites throw out the reproductive buds. These on a given colony, may be either all male, or all female, or there may be some male and some female, but the former disposition is the more usual.

Two methods of dispersal. When these reproductive buds reach a certain stage of maturity, it will be found that two different methods of dispersal are adopted.

"Reproductive" buds either fixed or free. In one case, the buds (of either sex) become detached and migrate, fertilization taking place either before or after. In the other they remain attached. The ova are set free on the spot and disperse, and are termed "planulæ."

"Swimming-bell." In the first case (mainly obtaining amongst the lower forms), the young bud is liberated; it then assumes the condition known as the swimming-bell, and propels itself through the water by means of cilia, to which reference is made hereafter. The bud itself is essentially a polypite, that is to say, it possesses a typical mouth and stomach.

Development of the "bell." The animal in the region of the tentacles becomes greatly expanded laterally at the expense of that portion of the body below the tentacles, and now takes a cup or saucer-like form, overhanging the free, oval end of the animal.

A bell with a clapper will serve as an illustration. The clapper representing the polypite with the mouth at the free end, the bell corresponding exactly to the large expansion of the base. Sometimes there is a thin membrane partly closing the mouth of the bell called the "**veil.**"

Radiating canals. Opening out of the base of the stomach and traversing the bell radially, like the ribs of an umbrella, are four or more channels which extend to the margin of the bell and unite by running along it; this canal system serves to convey nutriment from the stomach to parts of the bell.

Channels, the homologue of tentacles. It has been conclusively shown that these radiating canals represent the polypital tentacles* which are formed after the same manner as the buds, *viz.*: by the simple process of inflation, thus producing long, tubular processes, which, in most polypites are closed, but in some are open.

The bud, therefore, in progressing through the water, strongly contracts the bell, and thereby expels the water, the re-action

*See *Clavatella*, Hincks' Brit. Hyd. Zoophytes, p. 70, *et seq.*

carrying it backwards.* The bell then resumes its original form and the process is repeated.

"Bell" and mouth tentacles armed with dart-sacks. To complete the description of the fully-developed free bud. Tentacles are sometimes formed around the mouth and also from the margin of the bell, from which they hang as long streamers, and are armed with powerful batteries of dart-sacks.

Secondary tentacles. In a few species which have not the bell fully developed and therefore are not so well fitted for swimming, the bell-tentacles throw out near their ends secondary tentacles, and these they use with which to walk as on stilts. Sometimes suckers are formed at their ends.

Organs for seeing. At the base of the bell-tentacles are little granular masses of pigment, generally of an orange colour, in some cases a crystalline body is embedded in

*Amongst the Molluscs, the Cuttle fish and others of its kind, progress after the same manner, and in a backward direction, by the sudden expulsion of water from a kind of pouch. Some bivalves, also, propel themselves by suddenly closing their valves and expelling the water.

them. To these organs the power of sight is attributed. In addition, along the margin of the bell there occur other organs which have more the appearance of eyes, very prominent and staring in character.

Lithocysts, organs of direction. These are little globular sacks containing a calcareous spherule, and are termed lithocysts. It was formerly thought that they might have been organs of hearing, but they are now regarded as organs of the sense of direction, in steering a course.

Nerves and Muscles. With regard to the nervous and muscular systems entailed by the development of the "bell" for swimming purposes. Romanes, in his work on "Jelly Fish, Starfish and Sea Urchins," gives an interesting account of experiments in dissection which he carried out on the Hydromedusæ, pointing conclusively to a differentiation of tissue in the direction of nerves and muscles.

Two rings of nerves. It is now, however, established, that there exists around the margin of the bell, two rings of nerves and nerve cells, one ring occurring just above and the other just below the "veil" process.

Primordial centralized nervous system. These rings afford the earliest example of a central nervous system in the animal world.

As to muscles, the whole inner surface of the bell is lined by fine cancellated muscular fibres. Muscular tissue also occurs in the "veil."

Primordial specialised excretory organs. In some species of these medusoid free buds, "pores" occur leading out of the marginal canal. These pores subserve excretion of whole matter and mark the earliest occurrence of special organs for this purpose amongst animals.

In this free bud, which we have cursorily described, with its "bell" and trailing tentacles, we are introduced to particular forms of creatures, which are well-known as Jelly-fish, but whose life-history is not so fully understood.*

*A distinction must, however, be made between the naked-eyed and covered-eyed Jelly-fish; the hydroid offspring corresponding to the former only, the latter being the offspring of the higher hydrozoans.

Jelly-fish hatches her eggs, then called "planulæ." The freed bud, or jelly-fish, after seeing something of the world of waters around it, may, in the case of a female, settle down, attach itself to some object, and ultimately give birth to a family, the members of which sooner or later disperse. They do not, however, in this, the larval stage, resemble either the polypite or their immediate parent the jelly-fish, but are little, flat, conical bodies called planulæ, which, in their later stages, enclose a cavity and swim by means of cilia.

"Planula" is modified into a polypite. Later on they attach themselves to some object by their larger end, which expands and divides into root-like filaments. A mouth and tentacles are formed at the upper end and the result is a polypite, similar to that which originated the colony. These polypites will then proceed to carry out the principle of continuous budding, and thereby form fresh colonies.

First method of dispersal. "Reproductive" bud bodily transported. This is one method by which the ova are

transported, *viz.:* by the mother-bud freeing herself from the colony and bearing the brood away to another place, and thus establishing a new centre of distribution.

Second method. Bud remains attached, ova set free. The reproductive buds in this case remain attached to the parent, fertilization takes place, and the ova (planulæ) are set free, disperse, and go through the same modifications as the planules of the detached buds, preparatory to establishing fresh colonies in the same manner.

"Select" and "Reproductive" buds nearly obliterated. The buds styled "select" and "reproductive," demand some further remarks. In many cases, their real identity as originating in distinct buds is almost wholly lost, and it is difficult to recognize any trace of bud unless it is known that a solution of the difficulty is to be found in certain links or intermediate forms. We will, therefore, set those interested in such matters at once on their guard. Hincks calls attention to these gradations, and his work on the Hydroids should be consulted by all who desire to study this group of animals.

Modification and atrophy of "select" bud. Beginning with the "select" polypite, that is to say, with the individual which displays the first step in the series of phenomena connected with reproduction. In the lower division (ATHECATA or naked polypites) some members which bear the gonophores are not modified at all, but in many species the tentacles become more or less aborted and the polypite stunted, and when the higher division (THECAPHORA or sheathed polypites) is reached the "select" polypites do not obtain nourishment from external sources, in fact, they have no mouths and are wholly unrecognizable as polypites.

There is, however, one exception in this division, amongst our British species, and that exception is the Genus HALECIUM, *Oken*, where the "select" polypites are fully developed, in other cases they are represented by a mere stump ("Blastostyle") bearing the reproductive buds In THECAPHORA, that which represents the "select" polypite is provided with a receptacle, fairly strong and modified to the special circumstances of the case. This modified receptacle is more in the nature of a case

or vessel because it contains not only the aborted "select" polypite, but also the reproductive buds bearing the ova. It is therefore termed a "capsule."

Modification and atrophy of "Reproductive" bud. In the ATHECATA and simpler THECAPHORES, the "reproductive" bud is generally a Medusa, but in some species of ATHECATA the bud remains attached.

In the THECAPHORA, however, we soon reach a certain point—the turning point—where, as in such cases as *Gonothyræa Lovéni, Allman*, liberation fails to take place and thenceforward the *fixed* bud is the distinguishing feature. The bud having now become a fixture, loses its individuality and the bell and tentacles dwindle away and the creature wastes down to a mere sack, which contains in its walls the ova. The bud, in both ATHECATA and THECAPHORA, is nearly always enclosed in a fine envelope, which eventually ruptures.

We have seen, therefore, in the final stages, the "Select" bud and the "reproductive" bud, both becoming obsolete, and almost all that remains ostensibly in their place, are the ova within the Capsule. Under

these circumstances, it is difficult to discriminate between these two buds, and it will therefore be convenient when this is the case, to suppress their individuality and to refer to the whole body as the egg-capsule, or simply, the capsule. Where, however, the "select" polypite is recognizable, as in ATHECATA, and is distinct from the reproductive bud, the latter with its envelope is also called the "gonophore."

Process of Budding, and Budding of Medusæ. The process of budding, as previously stated, is by inflations of the body wall, which is composed of an inner and an outer layer. This process takes place not only in the polypites, but also in the Medusæ, in which latter case the buds are Medusæ.

Ovaries are situated in body wall, also in radiating canals of Medusæ. Ova are formed between the outer and inner layers of the alimentary cavity. This is the case also in the Medusæ, but with some of these ova also occur in sacks (inflations of the layers) in the canals which radiate from the stomach cavity. The important distinction between budding and ova-production should therefore be clearly understood.

Larva is a "planule," a polypite, an Amœba, or a Medusa. Hincks states that in nearly all species the ova develop into planules, and thence become modified into polypites; but in the fresh water Hydra and a few other species, the ova at once take the form of polypites. One instance he cites in which the egg gives place to an amœboid form. There are some cases also, where the ovum of the hydroid-medusa does not revert to the fixed hydroid state but is hatched out a Medusa.

Hydroids compared with the sponges. Having briefly considered the nature of the Hydroids, a few remarks may not be out of place to state in what respect they differ from their neighbours on either side.

The group of organisms immediately below the Hydroids, is the Sponges. They are a peculiar and somewhat anomalous group of animals. It is difficult to define their actual affinities..

Suppose, however, we take a densely-branching hydroid, such as *Eudendrium rameum*, *Pallas* and deprive the animal colony

of the horny covering, and also of the *polypites*, leaving only the stem and branches, *i.e.*, a system of tubes or channels (cœnosarc), with their ends open. Let there now be developed between the inner and outer layer (of which the cœnosarc, like the polypite, is composed) a middle and a much thicker layer of simple flesh substance called protoplasm, containing, however, numerous "flesh particles" or cells. If we then picture the cilia throughout this canal system maintaining by their movements a constant circulation, not of partly assimilated nutriment as in the hydroid colony, but water containing food which is supplied it to all parts of the system; and furthermore, that the larger end of the main channel or central stem, into which all other channels eventually lead, be open forming an exit for the impoverished water, we shall gain an approximate idea of the comparative systems of a hydroid colony and a simple sponge.

As we go higher in the sponges, instead of the channel being lined with cilia and exercising stomachic functions, the cilia become restricted to little chambers lined by cells of peculiar form (collar cells), where also

probably food assimilation is localized, thus suggesting a comparison with the stomach of the polypite.

To complete the sponge simile. Instead of the horny tubing suited to the hydroid form, there is an intricate network of horny fibres, serving as a skeleton to support the otherwise somewhat flaccid body-substance, and in addition, the structure is rendered more solid by the secretion of minute needles of carbonate of lime or flint, in the flesh and fibre. These needles may be the homologue of the calcareous skeleton of some hydroids, *e.g.*, a foreign species of HYDRACTINIA and the fossil *Parkeria* and others.

Hydroids compared with the Sea-anemones and the coral polyps. Higher in the scale of development, above the Hydrozoa, are placed the Sea-anemones and the Coral polyps. In the hydroid animals the stomach is a simple sack, but in the anemones and coral polyps a slight though important transformation has taken place. It is first indicated in the higher medusæ. Instead of the simple sack-like stomach, the mouth portion is turned inwards. (*e.g.* A certain kind

of non-spilling inkstand). The preparation of food is carried on by this portion. The interior is called the body cavity, as distinct from the stomach.

Arising out of the body wall and directed towards the pendant stomach or centre of the animal, are certain little vertical fleshy plates (Mesenteries). The anemones do not possess these modifications, but the coral polyps do, and in addition secrete carbonate of lime, or horny coral, in the deposition of which the mesenteries take part, by secreting what are known as the "septa," or rays of the coral.

Hydroids and Polyzoa compared. There is so much outward similarity between these hydroid-zoophytes and certain other creatures of much higher standing, *viz.*, the Polyzoa and Bryozoa (Molluscoida) that it may be desirable to point out the wide gap which separates these two groups.

In appearance, they have much in common. They are very minute; they have the habit of permanent budding (thereby producing plant-like growths); they secrete a polypary-like covering; the animals themselves are transparent, and have a circle of tentacles

arranged round the mouth. On examination under the microscope, however, a considerable advance upon the structure of the hydroid will be observed. There is a well-formed through alimentary canal, entirely cut off from the body cavity, there is also a gizzard, and well-defined, though simple, muscular and nervous systems. The polypary, as it may be called, partakes to some extent, of a horny substance, but carbonate of lime also enters largely into the composition, more especially in the higher forms. The receptacle also, or cell of the polyzoan is more a part of the animal than is the case in the hydroids, where the whole polypary hangs like a loose-fitting garment on the compound animal, the former condition resembling more the relation of the shell to the shell-fish in the ordinary mollusc, to which the polyzoan is nearly allied.

TABLE C.

Systematic Table to show the position of the
HYDROMEDUSÆ (CRASPEDOTA)
(HYDROIDS, HYDROZOA, and HYDROIDA, of various Authors)
in the classification of the CŒLENTERATA.

PHYLUM CŒLENTERATA.

Radially symmetrical animals with only one cavity in the body —the gastrovascular space—which serves alike for digestion and circulation. The generative cells are always either ectodermal or endodermal.

Sub-phylum I. CNIDARIA.

Cœlenterata with thread-cells.

CLASS I. HYDROMEDUSÆ (CRASPEDOTA).

Cnidaria in which the medusa has a velum and the polyp is without gastral ridges or filaments.

Order 1. HYDRIDA.

Solitary polyps without medusoid buds. Both generative products are developed in the ectoderm of the polyp.

Order 2. HYDROCORALLINÆ.

Colonial Hydromedusæ, consisting of a meshwork of cœnosarcal canals, the ectoderm of which secretes a hard calcareous matter, filing up the spaces of the meshwork. Polyps of two forms, gastrozooids and dactylozooids. 2 Families.

Order 3. TUBULARIÆ (GYMNOBLASTEA).

Without hydothecæ and gonangia. Polyps, when more than one, forming permanent colonies. Generative individuals, when set free, are Anthomedusæ. 4 Sections. 14 Families.

ANTHOMEDUSÆ. The Medusæ of this Order.

Craspedota without otocysts, with ocelli at the base of the tentacles, and with manubrial gonads; radial canals, usually 4, rarely 6 or 8; budded from polyps of the Tubulariæ.

4 Families. 13 Sub-families.

Order 4. CAMPANULARIÆ (CALYPTOBLASTEA).

With hydrothecæ and gonangia. Colonial. Generative individuals, when set free, are Leptomedusæ.

4 Sections. 7 Families.

LEPTOMEDUSÆ. The Medusæ of this Order.

Craspedota partly with, partly without otocysts; ocelli present or absent, gonads on radial canals; budded from polyps of the Campanulariæ. 4 Families. 13 Sub-families.

Order 5. TRACHOMEDUSÆ.

Hydromedusæ without hydrosome (polyp stage); with marginal sense-tentacles in pits or vesicles, with endodermal otoliths. Ocelli usually absent. Gonads radial. Radial canals, 4, 6, or 8, often with centri-petal canals. With thread-cell thickening of ectoderm round the edge of the umbrella.

4 Families. 8 Sub-families.

Order 6. NARCOMEDUSÆ.

Craspedota with free auditory tentacles. Tentacles inserted dorsally on the ex-umbrella, and connected with its edge by peroniums. Radial canals, when present, in the form of flat, radial, gastric pouches. 4 Families.

Order 7. SIPHONOPHORA.

Free-swimming polymorphic colonies of Hydromedusæ, produced by budding from an original, probably medusoid, individual. Gonads in gonophores, which, as a rule, are not set free.

Arranged by E. C. (After SEDGWICK).

PART II.

AN ACCOUNT

— OF THE —

BRITISH HYDROID ZOOPHYTES

— IN THE —

Hastings and St. Leonards Museum.

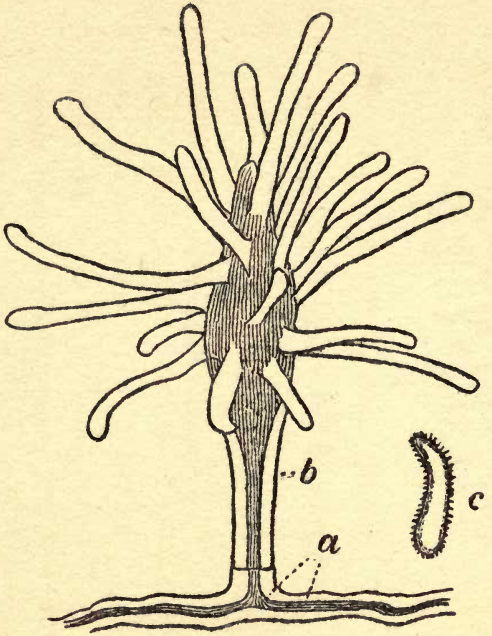


Fig. 2—An ATHECATE, or Polypite destitute of horny covering.

(a).—Polypary. (b).—Naked Polypite.
(c).—A Planule.

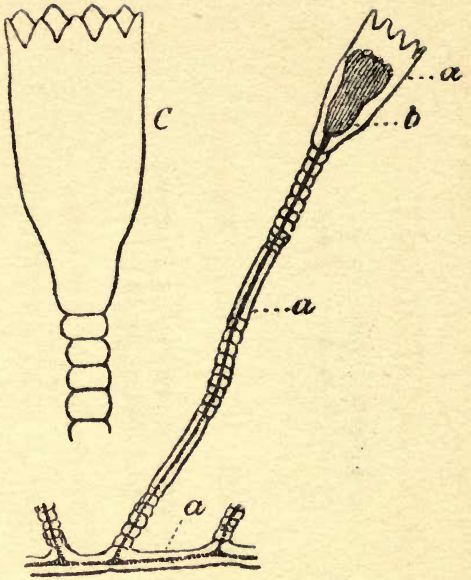


Fig. 3—A THECAPHOREAN Polypite provided with a horny covering, or receptacle.

(a).—Polypary. (b).—Polypite withdrawn.
(c).—Receptacle enlarged.

PART II.

AN ACCOUNT

—— OF THE ——

BRITISH HYDROID ZOOPHYTES

—— IN THE ——

Hastings and St. Leonards Museum.

The specimens were collected at HASTINGS by Philip James Rufford.

(The following classification is after Hincks).

Sub-kingdom—CŒLENTERATA.

Class—HYDROZOA.

Order I.—HYDROIDA.

Sub-order I.—ATHECATA (CORYNIDA).

Polypites naked—not provided with horny receptacles.

Family.—CLAVIDÆ.

Clava multicornis, Forstäl.

1 specimen in liquid.

SPECIMEN 1. The Polypite is club- or spindle-shaped, with the tentacles distributed over the body, the mouth being protruded conically. The gonophores are borne in clusters below the tentacles. This Hydroid is found creeping over stones, shells and seaweed, near low water, somewhat as Ivy trails over a wall; the adherent, creeping

stem throwing up, here and there, erect, slightly pink, and short polypites. The polypary rises only just above the creeping base. It is not common locally.

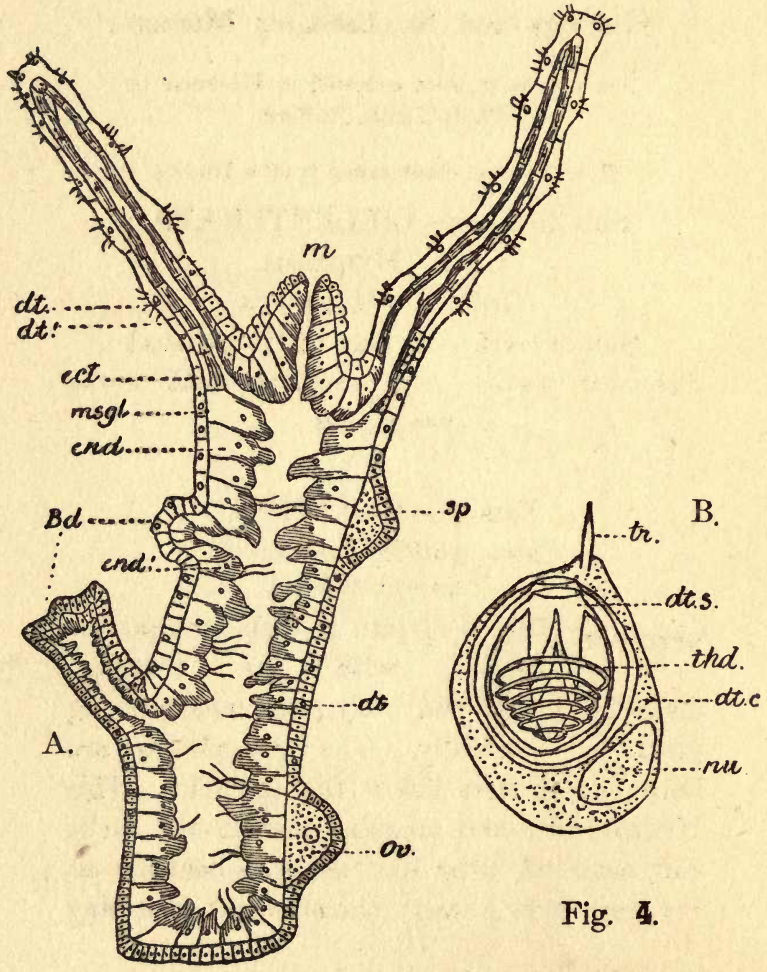


Fig. 4.

EXPLANATION OF FIG. 4.

The Structure of a typical Hydroid (Hydra), and the distinctive difference between Budding and Ova production; also a dart cell.

(From Parker and Haswell, after Schneider).

A.

m. Mouth.
end. Endoderm cell with pseudopodium.
end' Endoderm cell with flagella.
msgl. Mesoglæa, intermediate membrane.
ect. Ectoderm
dt. Large dart cells.
dt' Small dart cells.
bd. Bud.
ov. Ovum.
sp. Spermarium.

B.

tr. "Trigger-hair."
dt. s. Dart sack.
thd. Thread coiled within the sack.
dt. c. Dart cell.
nu. Nucleus.

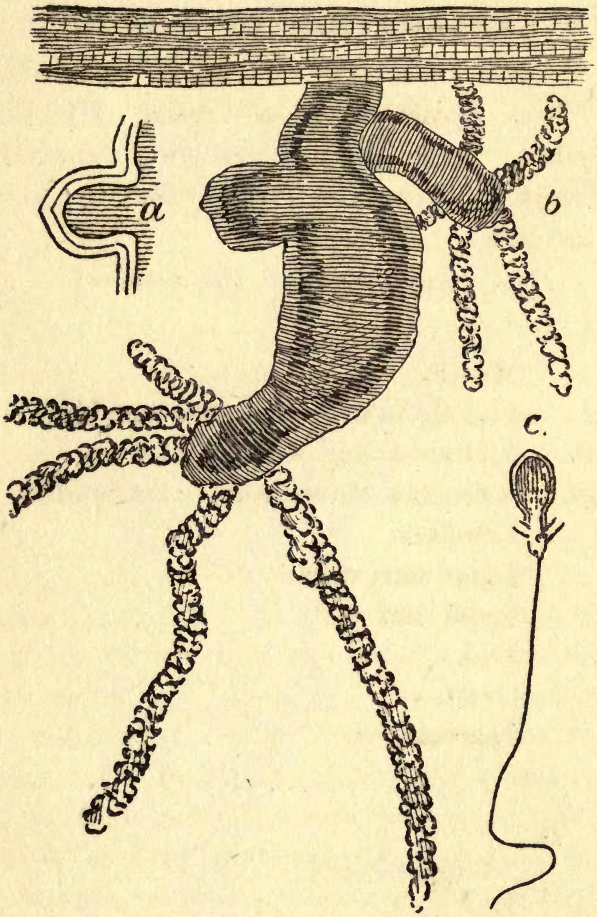


Fig. 5—*Hydra vulgaris*, Linnæus.

A solitary polypite.

(a).—Young bud, or "inflation" of body wall. Tentacles not yet formed.

(b).—More mature bud, with tentacles.

(c).—Dart.

Family.—HYDRACTINIIDÆ.

Hydractinia echinata, Fleming. (Fig. 7).

1 specimen dry and 1 in liquid.

SPECIMENS 2, 3. This Hydroid is peculiar on account of the form of the chitinous skeleton, and of the diversity of the members composing the colony. It is found at low or in deep water, encrusting whelk and other univalve shells inhabited by the common Hermit crab. According to Hincks, it is always found under these conditions, but we have found it on one occasion, on the claws of a large Lobster.

The ordinary alimentary polypite is white or pink, and in form very like the last species, but the tentacles are arranged in a single circle. In the "select" polypites, the tentacles are reduced almost to *nil*, but the remnants are well provided with dart sacks. The gonophores are collected together on the body, and are generally pink in colour. Besides these members, there are others similar in form, but much longer, and which have the habit of coiling themselves up, but they do not bear gonophores. They are

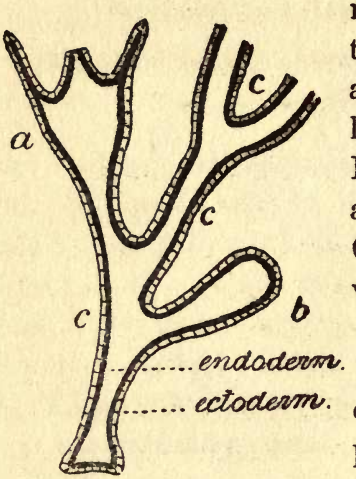


Fig. 6—Diagram to show the nature of "Budding."

(a).—Mature polypite.

(b).—Young bud, or "inflation" of the endoderm and ectoderm of parent—mouth and tentacles yet to be formed.

(c).—Cœnosarc, or connective parts.

mainly found around the mouth of the shell and are the "snake-like appendages" of Hincks. There is yet another modification. Certain long, linear, worm-like bodies, very contractile, with no tentacles or mouth, but well provided with dart sacks, whose function appears to have relation to either the special protection of the colony, or to be instrumental in procuring food for it. They are not generally distributed, but are found massed together. In some cases (if not in all) the walls of these attenuated worm-like bodies contain dart sacks. The heads appear to have a bi-lateral form. It is possible, as Hincks has pointed

out, that these, and the "snake-like" bodies may have analogy with the nematophores found in the PLUMULARIIDÆ, or to certain organs in *Ophiodes*.

The nature of the chitinous crust is not very clear. The plan, however, appears to be a system of horizontal horny tubes more or less irregular, compressed closely against one another, and opening into each other, thus forming a sheet which covers the surface of the whelk shell. The exposed surface of the tubes, or crust, is perforated similarly to perforated zinc, and allows the cœnosarc which fills up the interior of the tubes, also to overspread the outer surface of the crust. From this surface layer of cœnosarc the naked polypites emanate.

This species is named *Echinata*, from the spiny character of the crust, the spines evidently serving to protect the polypites from friction against objects in the many close corners into which the Hermit crab takes them. Beneath these spines, or pinnacles, the polypites crouch and remain unharmed.

As to the advantages to be derived from an association of crab and polypites, the latter, doubtless, partake of the crumbs that fall from the rich man's table, and also feed

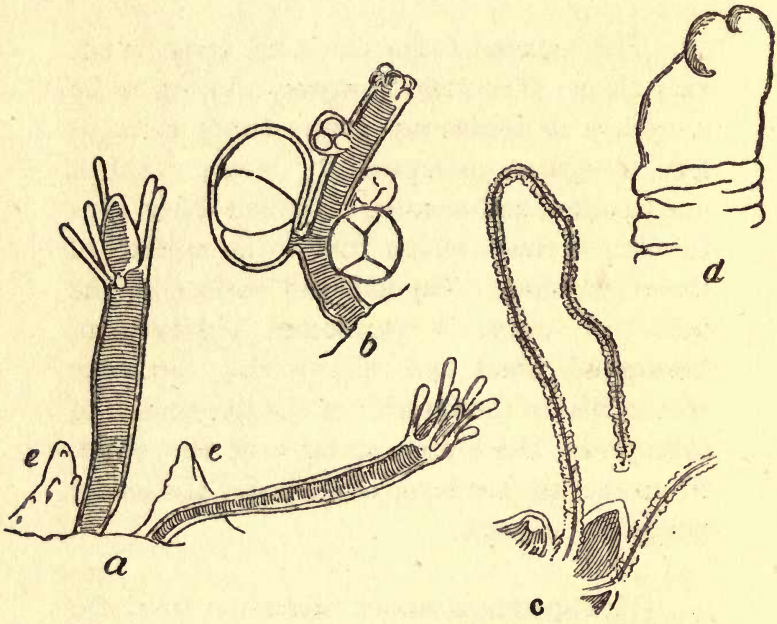


Fig. 7—*Hydractinia echinata*, Fleming. Enlarged.

(a).—Alimentary polypite.

(b).—"Select" polypite bearing the "Reproductive" buds containing ova.

(c).—Worm-like body ("tentacular filaments," Hincks), sometimes called dactylozoöid.

(d).—Enlargement of head of the same.

(e).—Horny spine of "crust."

upon small creatures such as *Infusoria*, which may be attracted thereto. The possible benefit derived by the crab may be found in the protection afforded against enemies (Fish, etc.), by reason of the poison darts of the polypites, but the polypites reap the main advantage, since they are, almost without exception, found associated with the crab, whereas the latter is more often found not accompanied by them.

This is a particularly interesting species, and the horny skeleton should be examined with a microscope, in connection with that of *Coppinia arcta*, *Antennularia ramosa*, and several other species.

H. echinata is common along our shores in warm weather, but the crab with its commensal retires to deeper water when the temperature is low.

When thickly covered with gonophores, the whole colony is a pink colour, and very noticeable.

Family.—CORYNIDÆ.

Coryne vaginata, Hincks. (Fig. 8 & PLATE II.)

2 specimens in liquid.

SPECIMENS 4, 5.

The polypite of *Coryne*, like that of the foregoing species, is club-

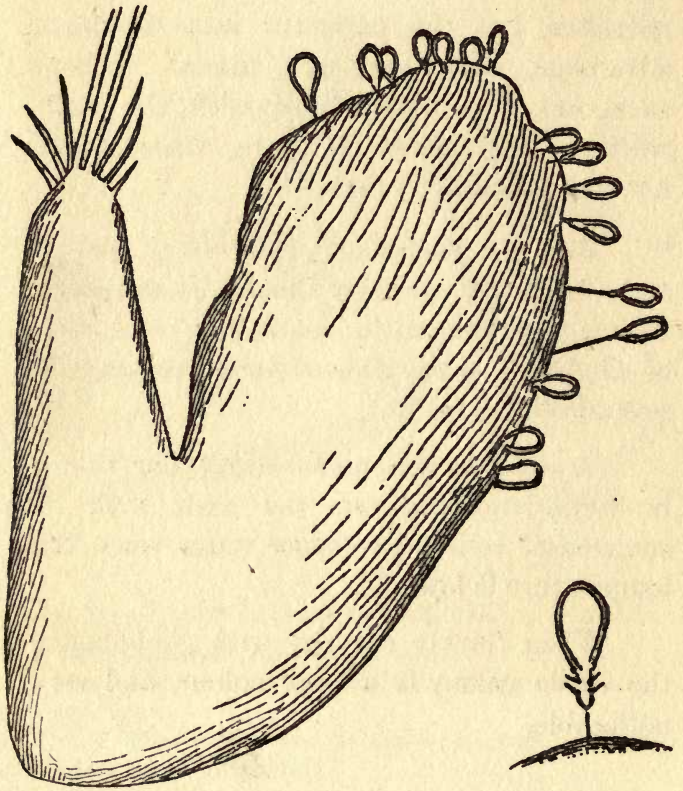
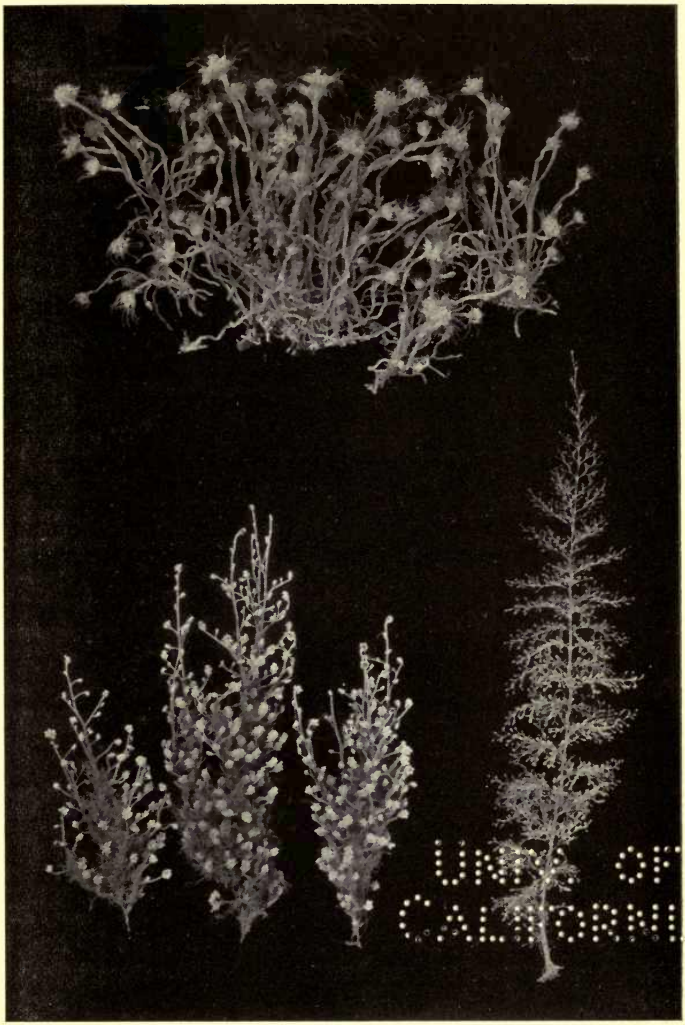


Fig. 8—A Goliath *(Cyclops)*

(a).—Slain by the darts of *Coryne vaginata*, in various stages of penetration.
(b).—A dart much enlarged.

1.



2. 3.

E. C. *Photo. ad nat.*

1. *Tubularia coronata.* Abildgard.
2. *Coryne vaginata.* Hincks.
3. *Obelia gelatinosa.* Pallas.

(All nearly nat. size).

shaped. The tentacles are distributed over the body, but they differ in having the ends knobbed, the knobs being fully armed with dart sacks. The gonophores are round or oval in shape, and are formed between the tentacles. The main stem is erect, and rises to a height of four or five inches. It branches at intervals and becomes several times pinnate, the polypites being terminal. The polypary is regularly ringed, and extends to the base of the polypite, where it slightly expands and is more or less wrinkled.

Coryne vaginata is common in rock pools from mid to low tide.

Family.—EUDENDRIIDÆ

Eudendrium ramosum, Linnæus. (PLATE III.)

2 dry specimens.

SPECIMENS 6, 7. Polypites pink with many tentacles in a single circlet. Stem long and alternately branching. Polypites terminal. The polypary is of a dark to light brown colour, extending to the base of the polypite but does not then expand.

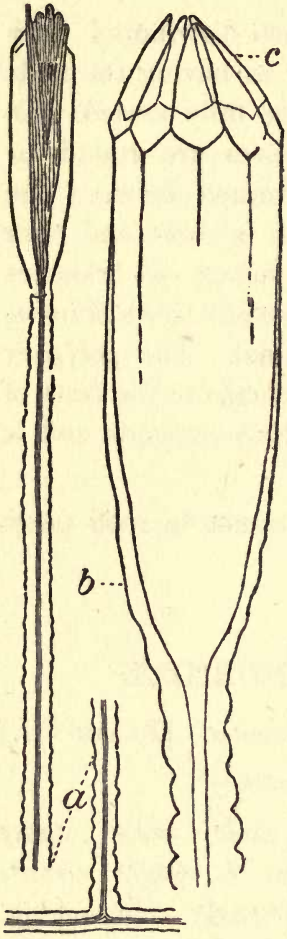


Fig. 9—A Hydroid.

(a).—The receptacle of which is furnished with a door or lid.
(b). — Receptacle enlarged.
(c).—Lid or 'operculum.'

Branches are annulated in the lower parts. This zoophyte is long and slender and of a switch-like character. It is trawled in shallow or deep water, and is rather common.

Eudendrium rameum,
Pallas.

2 dry specimens, 2 specimens in liquid.

SPECIMENS 8, 9, 10, 11.

This species has been aptly compared with an old weather-beaten tree. The main stem and branches are thick and strong, being formed of many tubes adherent together. The terminal shoots consist of single tubes which are short. The polypary is slightly ringed in places; the gonophores

E. C. *Photo. ad nat.*

Eudendrium ramosum. Linnæus.

(Nearly nat. size.)

are borne in bunches, like grapes, on polypite or cœnosarc; they are plentifully distributed over the specimens preserved in liquid.

Family.—ATRACTYLIDÆ.

Perigoniums repens, Wright.

Specimen on shell, in liquid.

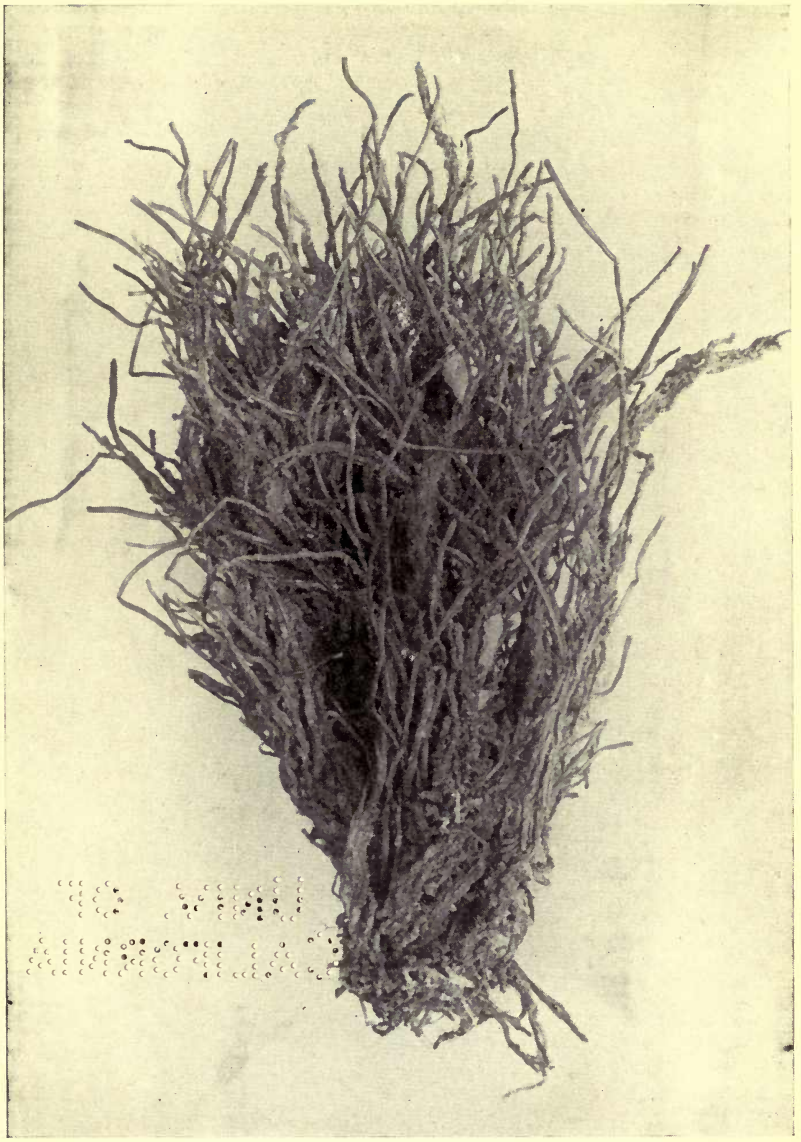
SPECIMEN 12. The polypite is club-shaped with a single circlet of tentacles, and arises by a stem from the creeping root-like cœnosarc. The polypary is of a reddish brown colour and extends to the base of the tentacles, where it expands into a cup-like receptacle, not, however, of such a finished character nor capable of covering the whole polypite as in the sub-order THECAPHORA. The gonophores are formed on the stem, the reproductive bud being a free medusa.

The species is rare at Hastings. It was trawled on *Nucula nucleus* together with *Lovénella clausa*, another rare species, on the same shell.

Garveia nutans, Wright.

3 specimens in liquid.

SPECIMENS 13, 14, 15. The Hastings specimens are found creeping up the stems and branches of other hydroids, such as *Hydrallmania*, throwing up simple stems with polypites and cœnosarc of a carrot pink colour, which readily catch the eye. The polypites are club-shaped. The tentacles number about twelve, and are in a single circle. The polypary is transparent and faintly ringed, and is expanded trumpet-wise, conformably with the polypites. The gonophores are round or oval, of an orange colour, and emerge from a slightly expanded polypary. The specimens were trawled off-shore, also from deeper water, and are somewhat rare. There are slight differences between the Hastings specimens, and those described and figured by Hincks, not, however, sufficient to warrant a fresh specific description, the main point of difference being, that in the present examples they are parasitic, and consequently do not require to form a strong compound stem.



E. C. *Photo. ad nat.*

Tubularia indivisa. Linnæus.

(Nearly nat. size).

Family.—TUBULARIIDÆ.

Tubularia indivisa, Linnæus. (PLATE IV.)

1 dry specimen and 1 specimen in liquid.

SPECIMENS 16, 17. The polypite of *Tubularia indivisa* is ovate in form, and reddish in colour. There are two separate rings of tentacles, one around the mouth, and the other at about the middle of the polypite. The gonophores are formed at the foot of the body-tentacles in stalked clusters. The polypary is neither branched nor ringed, and extends upwards to the base of the polypite. In these Tubularians the need of a support for the polypites suggests itself very forcibly; the body seems top-heavy and liable to break off when swaying with the movement of the water. This species is common in shallow or deep water off Hastings, but grows much finer in the latter situation. It requires to be preserved immediately on being taken.

Tubularia coronata, Abildgard. (Fig. 10 and PLATE II.)

1 specimen in liquid, also Medusoids in liquid.

SPECIMENS 18, 19. This species appears to be a rare visitant to Hastings, and will, therefore, receive more notice here than would

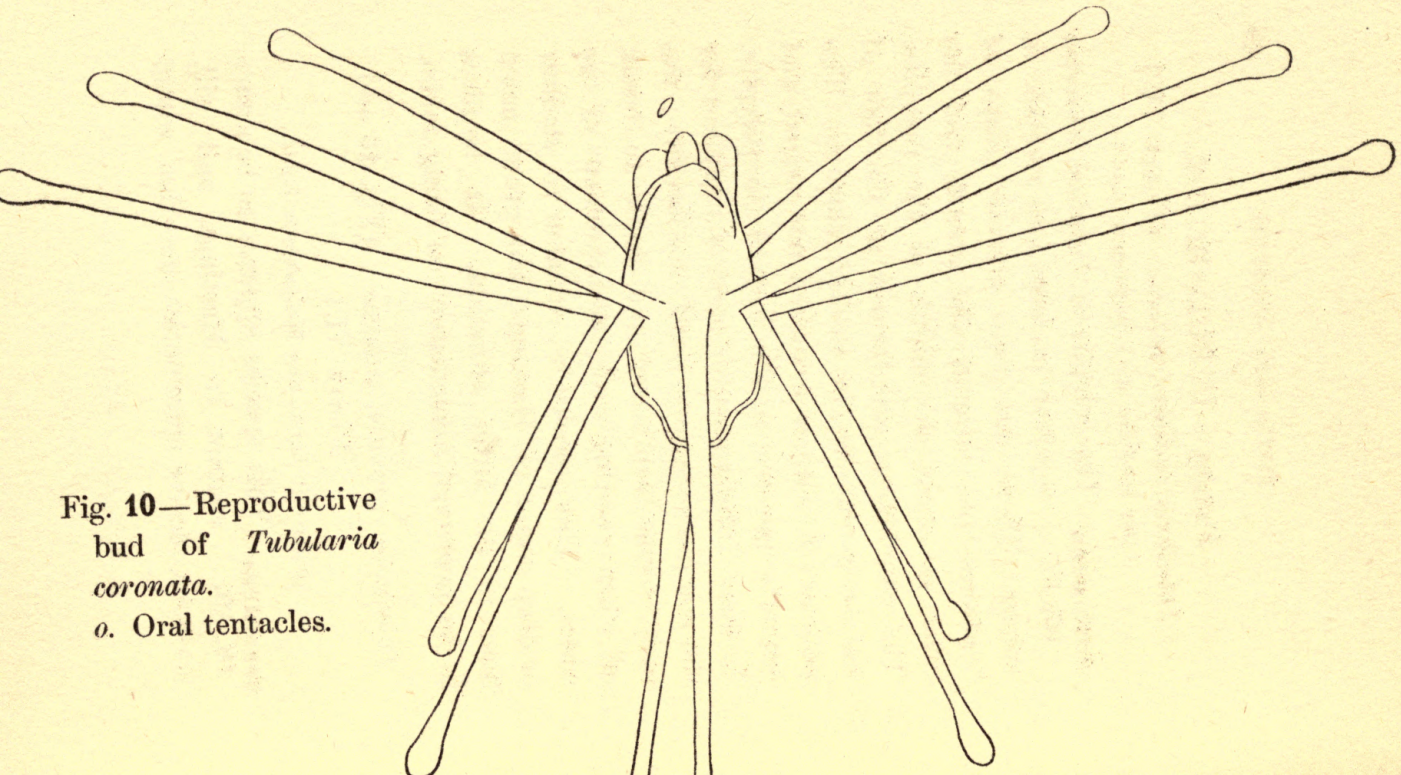


Fig. **10**—Reproductive bud of *Tubularia coronata*.
o. Oral tentacles.

otherwise have been the case. The zoophyte in Hastings specimens is from an inch to an inch-and-a-half high and branches very little. The polypary is transparent, white, or flesh-colour. The general colour of the polypites is orange-red, but this, on close examination, may be observed to be confined mainly to the proboscis and gonophores.

The polypites are similar in shape to those of the last species. The mouth is surrounded by a ring of about twelve tentacles, and around the body, near the base, is another circle of transparent tentacles considerably longer than those around the mouth, and numbering about twenty-five. Just within this circle of tentacles the gonophores are situated; they are oval and borne on short stalks, and are generally of an orange-red colour. The reproductive bud, on liberation, is medusa-form, but without the bell, and of an elongated egg shape, with a slight constriction towards the basal or larger end. At the narrower end, where the mouth is situated, there are four short and thick tentacles which are very similar in size and appearance to the tubercles which are

noticeable at the apex of the gonophores before liberation. About midway down the body, there is a ring of much longer tentacles, clubbed at their ends. This feature appears to be an important specific character. These long tentacles number from about nine to twelve, each alternate one being raised, and the others lowered, with a slow finger-like motion.

On liberation, these little creatures appear rather sluggish in action and ill-adapted for locomotion, since they have no bell, nor are the tentacles specially suited for walking. It appears to be a matter of indifference to them whether they rest upon the base of the body, or on the tentacles. Hincks states that they can use the tentacles as oars. This method of progression was not noticed in the Hastings specimens, although these buds were given off in a glass vessel without persuasion. *T. coronata* appeared along the Hastings coast in the latter half of the year 1897, in great profusion, and was found from about half tide to low tide. Towards the end of the year, rough weather set in, and destroyed all the colonies, which, however, by this time,

had mostly shed their reproductive buds. Neither before, nor since this period, has this species been recorded for Hastings. It came in great profusion, and vanished suddenly, and completely. Possibly some unusual set of the sea-currents may have brought the embryos to this shore. The specimen in the preservative bears the gonophores, and the free reproductive buds will be found separately in a tube.

Sub-order II.—THECAPHORA.

Polypites provided with cup-like receptacle of the Polypary.

Family—CAMPANULARIIDÆ.

Clytia Johnstoni, Alder. (Fig. **11**).

2 specimens in liquid.

SPECIMENS 20, 21. With this species is introduced those hydroids in which the polypary is extended, and expanded into a finely formed cup, so as to provide protection and support to the polypite. In *Clytia Johnstoni*, the unbranched stems rise from the creeping base bearing at the ends beautiful

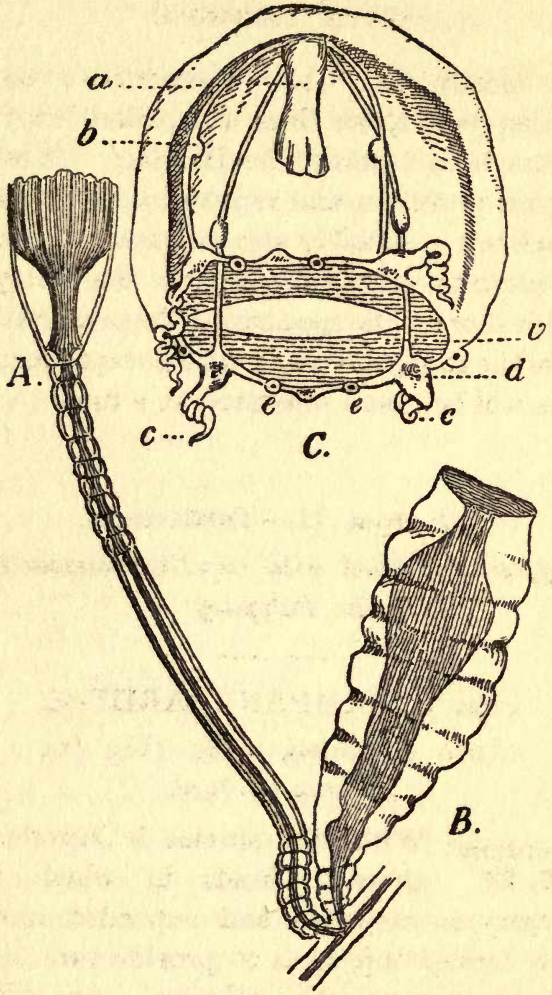


Fig. 11—A typical Hydriod *Clytia Johnstoni*, with its free Reproductive bud, or Medusa.
(Enlarged.)

cup-like receptacles with toothed rims, in which the polypite is comfortably ensconced, and where it can expand or withdraw at will.

In the ATHECATA, two species *(Perigonimus repens* and *Garveia nutans)* have been mentioned in which a rough expansion of the polypary takes place, but there is a great difference between those species and the beautifully finished chalices of the THECAPHORA, of which *C. Johnstoni* forms a good example. The stems are ringed or wrinkled at the top and bottom, and occasionally in the middle. The polypite has a single circle of tentacles. The gonophores are borne on the creeping

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(A).—"Alimentary" polypite, tentacles retracted.

(B).—"Select" polypite and modified receptacle, the reproductive buds being produced within the darkly shaded enclosure which represents the "Select" polypite.

(C).—The freed reproductive bud, or jelly fish, seen rather from below.

(a).—Stomach, or polypite, with the mouth at the free end.

(b).—One of the radiating canals, with reproductive sack.

(c).—Bell tentacles.

(d).—Organ of sight, Ocellus.

(e).—Lithocyst.

(v).—Veil, a thin membrane partly enclosing bell-cavity.

base, or occasionally on the stem, the horny receptacles or capsules of these being ringed or wrinkled. The reproductive bud is a free medusa with four canals radiating from the stomach to a canal around the margin of the bell. At each of these four points, there is given off a tentacle. Midway between these are swellings representative of other and rudimentary tentacles. On either side of these the eye-like lithocysts occur. The bell is a very beautiful object; transparent and finely spangled with opaque white dots. The mouth of the bell is partly closed by a fine membrane, the veil.

Obelia geniculata, Linnæus.

1 specimen in liquid.

SPECIMEN 22. The genus OBELIA differs from the genus CLYTIA mainly as regards the reproductive bud, which, as in the previous specimen, is a medusa, but the bell in OBELIA is almost flat or saucer shaped, and the tentacles around the bell are far more numerous. The creature has a peculiar habit of swimming sometimes with the mouth

uppermost, and the bell turned inside out. When in that condition, it is highly suggestive of an umbrella in a like predicament.

The specific name is very appropriate, signifying bent like the knee. It may be called the zig-zag hydroid, a term which equally well describes it. The hydroid throws up zig-zag stems, and from each bend rises a short ringed shoot bearing a polypite, the receptacle of which is somewhat triangular with a plain rim. The capsules which are large, and urn-shaped, are borne in the axils of the shoots. This species is very common and overruns many objects.

Obelia gelatinosa, Pallas. (PLATE II.)

1 specimen in liquid.

SPECIMEN 23. This is one of the tallest and most conspicuous of the shore* hydroids. The stem is compound, some five or six inches in height, with branches arranged in whorls around the axis; these, again, throw out secondary shoots. The polypary is ringed just above the branching, and the receptacles

* *i.e.* Growing on rocks, stones, &c., between tide-marks.

are somewhat deep, the rim of which, according to Hincks, is castellated, or squarely toothed. This character we have not observed in the Hastings specimens, although they must, undoubtedly, be referred to the same species. The capsules are borne in the axils of the branches and are about twice the size of the polypite receptacle.

This hydroid is found plentifully on stones and rocks near low water, very often in flat, exposed situations, and apparently it does not object to muddy surroundings.

Obelia longissima, Pallas.

1 specimen dry.

SPECIMEN 24. This species is tall, delicate, and attenuated in mode of growth. The specimen when living, measured about twelve inches in height. The main stem is simple, with branches thrown out alternately around the axis, at which points, the stem bends slightly outwards, the polypary being ringed above the branching. The rim of the receptacle is squarely toothed as in the last species. The capsule is wider and not so elongated.

This species is common in deep water, and may be found amongst the trawlers' rubbish, where it has much the appearance of tangled horse-hair.

Obelia dichotoma, Linnæus.

1 specimen in liquid.

SPECIMEN 25. This specimen is apparently *Obelia dichotoma*. It bears a great resemblance in details to *O. gelatinosa*, and *O. longissima*, but differs from *O. gelatinosa* in habit, and in the stem being simple instead of compound; from *O. longissima* in form, habit, etc.; and from both because the rim of the receptacle is not toothed.

The specimen is on a fragment of *Tubularia*.

Not very common.

Campanularia verticillata, Linnæus.

1 specimen dry, 1 in liquid.

SPECIMENS 26, 26a. This is a very distinctive species. The stem is compound and throws out around its axis branches which branch again. The polypites are borne on rather

long straight shoots, more or less distinctly ringed, and the rim of the receptacles is indented. The capsules are somewhat oval, with the upper part gradually drawn out to a narrow neck. They are formed on the stem and branches generally. This has been called the Horse-tail hydroid, since it bears some resemblance to the plant *Equisetum*. It is not uncommon in the trawl from deep water, but is not a shore species.

Lovénella clausa, Lovén.

On specimen number **12.**

SPECIMEN 27. This is a beautiful and apparently rare species. It throws up from a creeping base, simple, generally unbranched, stems, more or less ringed or wavy, with terminal polypites. The receptacles are deep and taper gradually downwards, the thickness of the chitine being greater towards the base. The rim of the receptacle is scalloped, producing slight angularity at each crenation. The special peculiarity of this species is, that when the polypite retires into the receptacle, pointed

prolongations of the receptacle are directed to a central point, and, closing over the polypite, form a conical roof. Capsules not present. Rare. (See Fig. 9.)

Opercularella lacerata, Johnston.

1 specimen in liquid, on a Polyzoan.

SPECIMEN 28. An extremely delicate species, and one very readily overlooked. In the present specimen, it is found running up the stem and branches of a polyzoan, *Anguinella palmata*, Van Beneden, from which, with great care, it could be removed. It gives off ringed undulatory stems with short ringed side shoots, bearing ovate receptacles. These are produced beyond the rim, with points, which meet conically over the aperture, forming a lid. The polypite is long and linear, and when expanded extends fully the length of the receptacle beyond it. The mouth is slightly conical, and the tentacles are long and number about sixteen. Capsules not present.

This species bears a very close resemblance, in many respects, to *Calycella syringa*, Linn.

Found near low water.

Family—LAFOËIDÆ.

Lafoëa dumosa, Fleming.

1 dry specimen, 1 specimen in box.

SPECIMENS 29, 30. This hydroid is found either twining up some other species or over running other objects, and in this, the creeping condition, the stem is simple (single). In another phase, the stem is erect and branching, in which case it is compound, as are also the branches. This habit of producing a compound stem is apparently induced by the need of stiffening and support for the zoophyte. The receptacles are tubular and somewhat curved. There is a short pedicel, and in the upright form the receptacles are arranged around the axis. Capsules not present.

This species is common in deep water.

Two other species, *L. pocillum* and *L parvula*, Hincks, have been found locally.

Filellum serpens, Hassall.

1 specimen.

SPECIMEN 31. The character of this species is similar to that of the last, but the stem is creeping and reticulate, and is set in a

horny crust. The receptacles are curved, bearing some resemblance in shape to the old-fashioned powder horn. The lower half of the receptacle is adherent to the crust. *F. serpens* is very common on the stems of other hydroids, rarely on shells.

Family—COPPINIIDÆ.

Coppinia arcta, Dalyell. (FIG. 12.)

1 dry specimen in box.

SPECIMEN 32. The receptacles are long, tubular, and curved, and are set in a horny cellular crust which invests the tubes of other hydroids. A comparison of sections of this crust with that of *Hydractinia*, and the stem of *Antennularia ramosa*, and others, will be found instructive.

Common in the coralline zone.

Family—HALECIIDÆ.

Halecium halecinum, Linnæus.

1 specimen dry, of exceptionally fine growth.

SPECIMEN 33. This has been called the herring-bone hydroid, because the stem and main branches, which are compound, throw out regular, alternate, lateral branches.

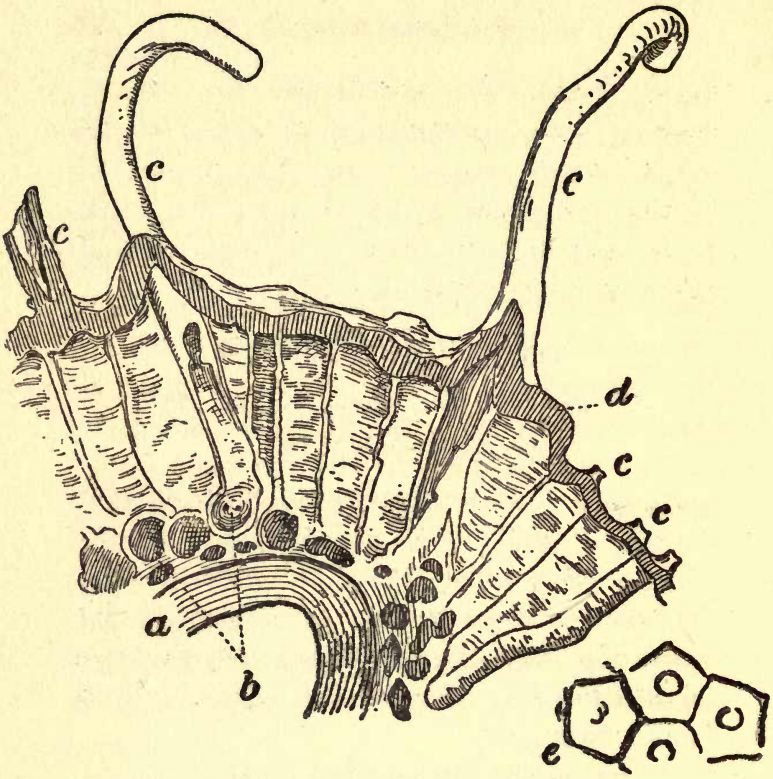


Fig. 12—Transverse section of polypary of *Coppinia arcta* for correlation with crust of *Hydractinia* (Fig. 7), and the section of stem of *Antennularia* (Fig. 13).

(a).—Zoophyte stem, upon which *Coppinia arcta* is parasitic.

(b).—Horizontal cells or tubes (?), from which arise the vertical tubes c.

(c).—Vertical polypite tubes.

The receptacle is tubular and telescopic in appearance. The male and female capsules differ in shape. Hincks* draws attention to the fact (it is well worth personal observation) that in the case of the female capsules of this genus, they are surmounted by two fully developed "select" polypites; and he cites this as the only case among the THECAPHORA in which these are not entirely suppressed. This fact should be carefully noted. In this species the mouth of the capsule projects beyond the ovary.

Common in the trawl, more especially in rather deep water, but is not of particularly fine growth.

(d).—Thick floor of chitine.

(e).—Appearance of tubes on surface.

In the horizontal cell or tube from which the left hand vertical tube arises, are seen two dots, which probably represent openings in connection with other tubes or cells. The system is practically the same as in *Hydractinia* and *Antennularia ramosa*, and others.

* *A History of the British Hydroid Zoophytes.* Vol. I. p. 221.

Halecium Beanii, Johnston.

1 specimen dry.

SPECIMEN 34. *Halecium Beanii* may be known from the last species by its very delicate character, and instead of the straight, rigid appearance, the tender branches are rather zig-zag, giving off the shoots at the angles. The "select" polypites are fully developed, as in *H. halecinum*, but the region of the capsule where the eggs are located, protrudes beyond the mouth of the capsule. This, however, is not so in the other species.

Family—SERTULARIIDÆ.

Sertularella polyzonias, Linnæus.

3 dry specimens, and 1 specimen in box.

SPECIMENS 35, 36, 37, 38. This family exemplifies those hydroids in which the receptacles are unstalked and arranged on opposite sides of the axis. This is a lowly and straggling form, the stem not being appreciably stronger or thicker than the branches. It overruns many objects, especially *Flustra* (a Polyzoon). The receptacles

are alternate, giving a slightly zig-zag appearance to the growth, and are not wrinkled as in *S. rugosa.* The capsules are ovate, wrinkled, aud have a slight neck to the aperture. Very common.

Sertularella Gayi, Lamouroux.

2 dry specimens.

SPECIMENS 39, 40. This species bears much resemblance to the last, but has a compound stem, and consequently, a much stiffer appearance. The receptacles are slightly wrinkled and are alternate. The capsules are somewhat spindle-shaped, and are only wrinkled in the upper part.

Less common than *S. polyzonias,* and from the trawl only.

Sertularella rugosa, Linnæus.

1 specimen in box.

SPECIMEN 41. This might be truly called the wrinkled *Sertularella.* The specimen exhibited has overrun a piece of *Flustra* (a Polyzoon), throwing up here and there

small shoots, densely crowded with ovate, alternate receptacles; features in which, as also in the marked wrinkling, they much resemble the capsules, which, however, are very much larger. Common.

Sertularella tenella, Alder.

1 specimen in box on *Flustra*.

SPECIMEN 42. This specimen appears to combine to a great extent, the characters of *S. tenella*, Alder, and *S. fusiformis*, Hincks. The stem is very zig-zag, the angles formed being almost right-angles. The receptacles are too short for *S. fusiformis*, and although apparently smooth, in most instances this is probably due to the age of the specimen, as in some specimens they are wrinkled. The rim is four-toothed. The capsules are oval, ribbed, and with dentate apertures, but in many cases they appear plain. It is a pretty little species and nearly allied to *S. rugosa*.

Diphasia rosacea, Linnæus.

2 dry specimens, and 2 specimens in boxes.

SPECIMENS 43, 44, 45, 46. This a most delicate and elegant species. It is generally found trailing over hydroids and

E. C. *Photo. ad nat.*

Sertularia pumila, Linnæus.

On stems of *Fucus serratus*.

(Three-fourths nat. size.)

other objects, throwing up stems, curving and tendril-like towards the tips, which grasp any object for support. Side branches, which hardly differ in size from the stems, are given off alternately; the receptacles are tubular and occur on both sides of the stem oppositely. The apertures are furnished with a lid or operculum. The capsules differ in each sex; the male is cylindrical in shape, lobed lengthwise, and surmounted by a crown of spines; the female is somewhat pear-shaped, with a supplementary chamber for the maturing ova, and with two prominent incurved spines at the crown. Specimens showing both forms of capsule are exhibited in the glass-topped boxes.

Common in the trawl.

Sertularia pumila, Linnæus. (Plate V.)

2 dry specimens on sea-weed.

Specimens 47, 48. *Sertularia pumila* covers with great profusion, various sea-weeds between mid and low tide. It is of a stronger and closer build than *S. gracilis*, but shorter and more branching, the branches often being

opposite. The receptacles are tubular and opposite; the capsules are ovate, tapering to a short pedicel. There is a slight collar to the aperture. Very common.

Sertularia gracilis, Hassall.

1 dry specimen, and 1 specimen in box.

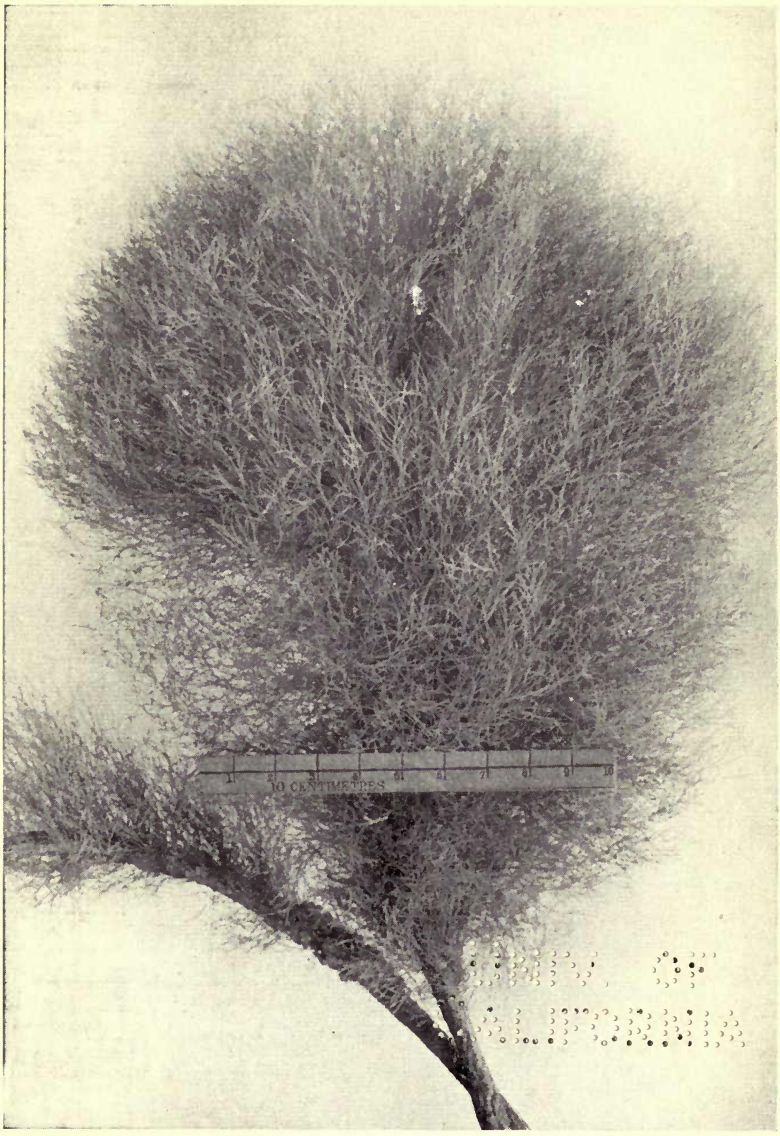
SPECIMENS 49, 50. A species of particularly fine habit. It is symbiotic on other hydroid stems, over which it grows, throwing up short and fine stems. The receptacles are opposite and tubular, the rim being sharp. The female capsule is ovate with a narrow collar-like aperture. They may be seen on the specimen in the glass-topped box.

Not common.

Sertularia operculata, Linnæus. (PLATE VI.)

2 dry specimens, and 1 specimen in box.

SPECIMENS 51, 52, 53. The stem of this species is very delicate, branches distantly in a dividing manner, and produces colonies of enormous extent, and luxuriant in growth. It has been called the "sea hair" hydroid. The



E. C. *Photo. ad nat.*

Sertularia operculata, Linnæus.

On stems of *Laminaria*.

(Six-tenths nat. size.)

The Scale is 10 Cm.

receptacles are tubular and are arranged oppositely on each side of the stem ; the outer lip of the margin being very sharp and pointed. The capsule is somewhat balloon-shaped, with a plain aperture. It is often symbiotic on *Laminarian* stems and Mussel valves. It would hardly be venturing too far to say, that the colony here shown on the *Laminarian* stem (see plate VI.) probably equals innumber the population of London. The previous species might be regarded as a dwarfed form of the present; *S. operculata*, however, is vastly more profuse in its growth. It is common in the trawl.

Sertularia abietina, Linnæus.

4 dry specimens, and 1 specimen in box.

SPECIMENS 54, 55, 56, 57, 58. This species has been popularly called the "Sea-fir." The main stem grows to a considerable height, and throws out alternate lateral branches which in some specimens branch again. The receptacles are sub-opposite ; the capsules are ovate,

wrinkled, and slightly tapering at the base. Often grows upon scallop valves and on rocks. Trawled from rather deep water.

Sertularia argentea, Ellis and Solander.

2 dry specimens, and 1 specimen in box.

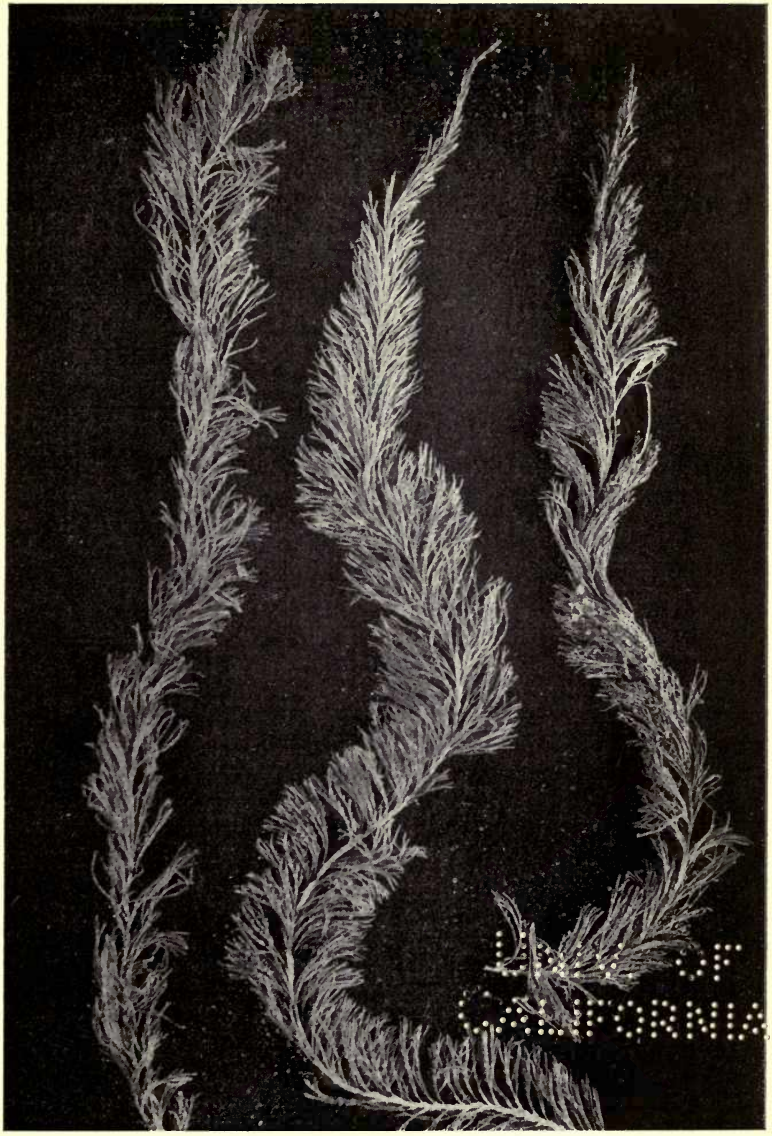
SPECIMENS 59, 60, 61. This is a very elegant species. The stems produce alternate short branches, each branch giving out other short branches in a palmate manner. The receptacles are sub-opposite and sharp-tipped. The capsules are somewhat shield-shaped. Trawled from moderately deep and very deep water.

This species, and *S. cupressina* are often chosen for decorative purposes.

Sertularia cupressina, Linnæus. (PLATE VII.)

2 dry specimens.

SPECIMENS 62, 63. Somewhat like the last species in habit, but the stem is much longer and more tapering. It throws out short branches, mainly alternately, which immediately fork and re-fork in a palmate



E. C. *Photo. ad nat.*

Sertularia cupressina, Linnæus.

(Three-fourths nat. size.)

manner, as in the previous species. The receptacles are sub-opposite and directed forward. The outer lip of the aperture is sharp and pointed. Receptacles and stems both have a slightly compressed appearance. The capsules are of an elongated shield shape, the upper corners being prolonged into spines; they are numerous on the specimens exhibited. Not uncommon in the trawl, or thrown upon the shore.

Hydrallmania falcata, Linnæus.

3 dry specimens and 1 specimen in box.

SPECIMENS 64, 65, 66, 67. The stem is long and spirally twisted, giving off alternate, regular, pinnated, palm-like branches, each pinna or side-branchlet bearing on its inner side only, the jug-shaped receptacles, which are crowded together. The capsules are oval, with a slight collar to the aperture. The spiral stem gives to this species a specially graceful character.

Very common in the trawl and often along the shore.

Family—PLUMULARIIDÆ.

Antennularia antennina, Linnæus. (PLATE VIII.)

2 dry specimens and 1 in liquid.

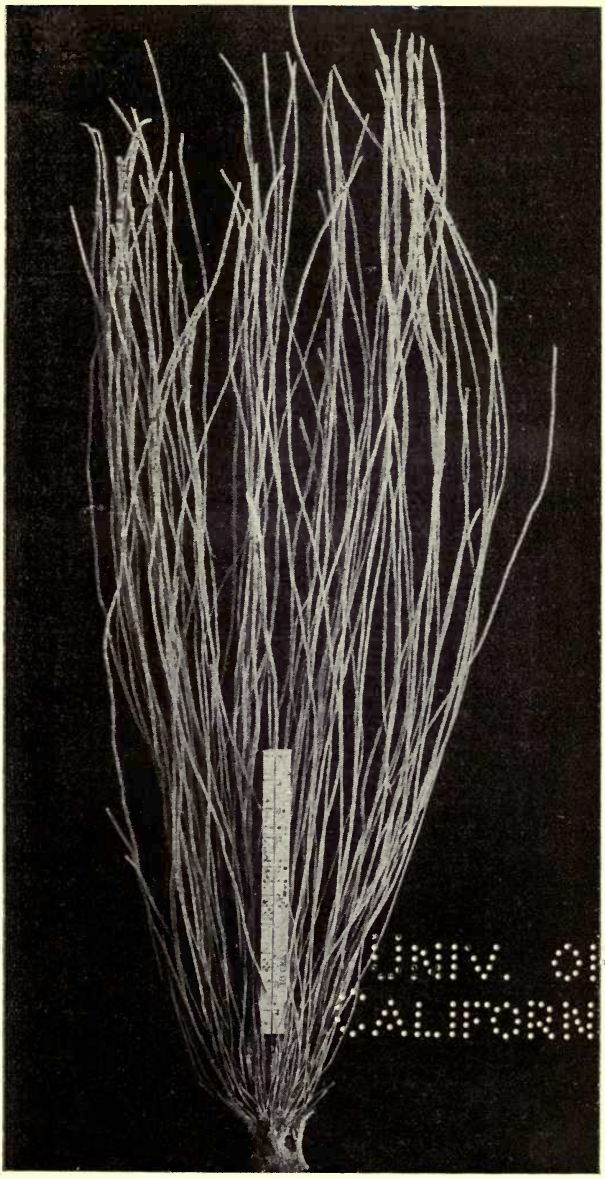
SPECIMENS 68, 69, 70.

This species has been well named the "Antenna-like" hydroid.

It throws up long, straight stems, and at short intervals, gives out in nodes, like the plant *Equisetum*, short, fine, radiating branches, bearing on the upper side only, shallow tea-cup-like receptacles. Nematophores are plentifully distributed, one on either side above, and one below each polypite, with others on the stem. The capsules are oval with an oblique truncated aperture. They may be seen on the specimen preserved in liquid, likewise the fine branches and receptacles.

This species is generally found growing on scallop valves in deep water, and is common off Hastings.

Two very curious species of Nudibranch Molluscs, *Doto Coronata* and *D. pinnatifida*, feed upon the polypites, and also attach their spawn to the stems.



E. C. *Photo. ad nat.*

Antennularia antennina, Linnæus.

(Four-tenths nat. size.)

The Scale is 10 Cm.

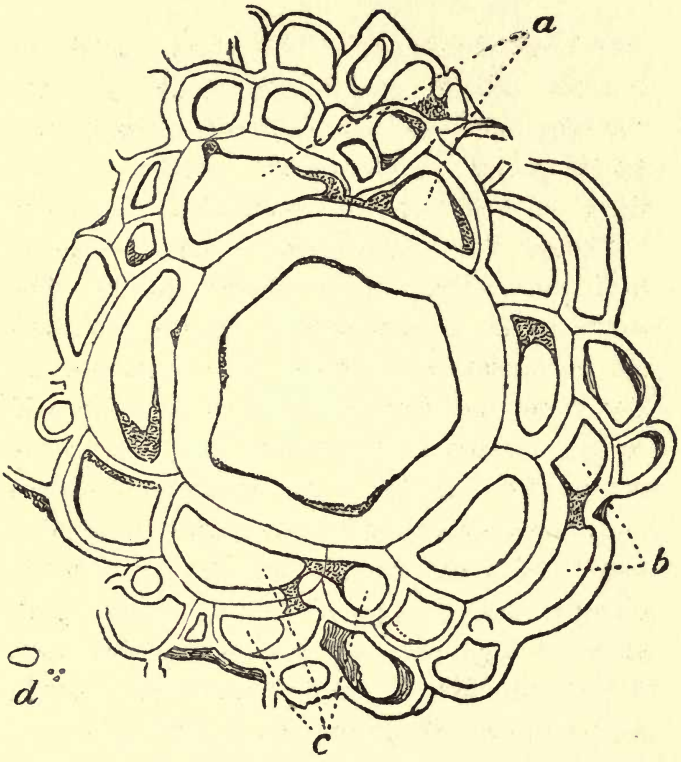


Fig. **13**—Transverse section of stem of *Antennularia ramosa*, Lamarck. (Magnified).
(a b c).—Tubes opening into one another.
(d).—Dart sack from cœnosarc.

Antennularia ramosa, Lamarck. (PLATE IX.)

2 dry specimens, 1 specimen in liquid.

SPECIMENS 71, 72, 73. This species does not attain so great a height as the last; the stems, also, branch frequently, although

somewhat irregularly. The stems and the branches throw out at the nodes, delicate radiating offshoots, bearing receptacles on the upper sides. These are similar to the receptacles of the last species, but the nodes are much closer, and there is some variation in the distribution of the nematophores. The capsules are horn-shaped, a drawn out and curved variation of those of the last species. The stem and branches of this species will repay microscopic examination. A transverse section (see fig. **13**) shows many other tubes of various shapes and sizes running parallel with, and arranged around, the main tube, pressed tightly against each other, and annealed together. Many of these tubes open into those adjoining and into the main tube; the cœnosarc, therefore, is uninterrupted.

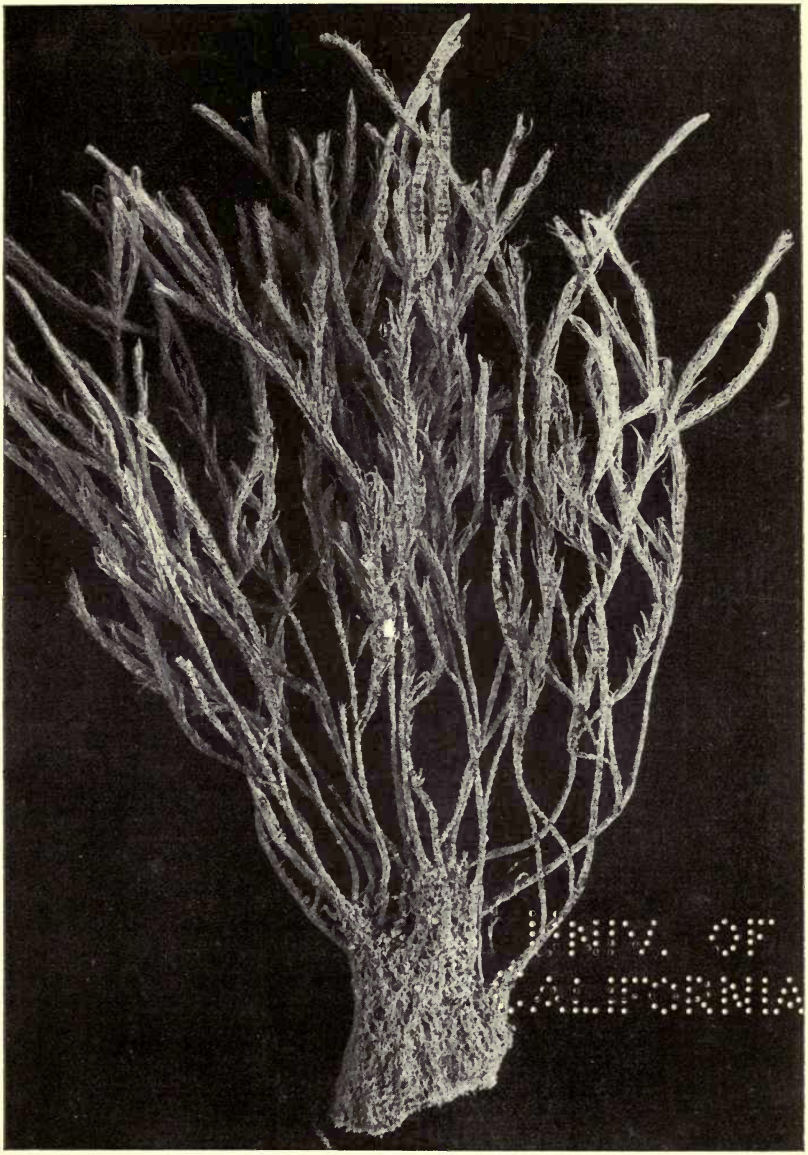
Not uncommon on the scallop valves in deep water.

Aglaophenia pluma, Linnæus. (PLATE X.)

2 dry specimens, also 1 in liquid and 1 in box.

SPECIMENS **74, 75, 76, 77.**

After storms, when sea-weed in large quantities is thrown upon the beach, *A. pluma* may frequently be found on *Halidrys siliquosa*,



E. C. *Photo. ad nat.*

Antennularia ramosa, Lamarck.

(Five-sixths nat. size.)

Lyngb. It winds its loose mesh of fibres around stem and branches, and throws out, in every direction, graceful, pinnated plumes, which resemble fronds of tree-fern or palm. The receptacles which are somewhat cup-like, with the margin irregularly dentate, are borne on one side only of the axis. The nematophores are confined to the region of the receptacles, and their peculiar movements are worth attention. The capsules in this, and some other species are additionally protected by a modification of the palm-like branches; the delicate side branches being folded around the capsule to which they are united. These "ribs" are studded with nematophores.

Plumularia pinnata, Linnæus. (Figs. **14, 15.**)

3 specimens in liquid.

SPECIMENS **78, 79, 80.** A very lovely and delicate species of a semi-transparent, white hue. The creeping base throws up stems regularly and alternately branched, which, towards the apices, curl over like a feather. The receptacles are arranged along the upper side of the branches. The gonophores are crowded

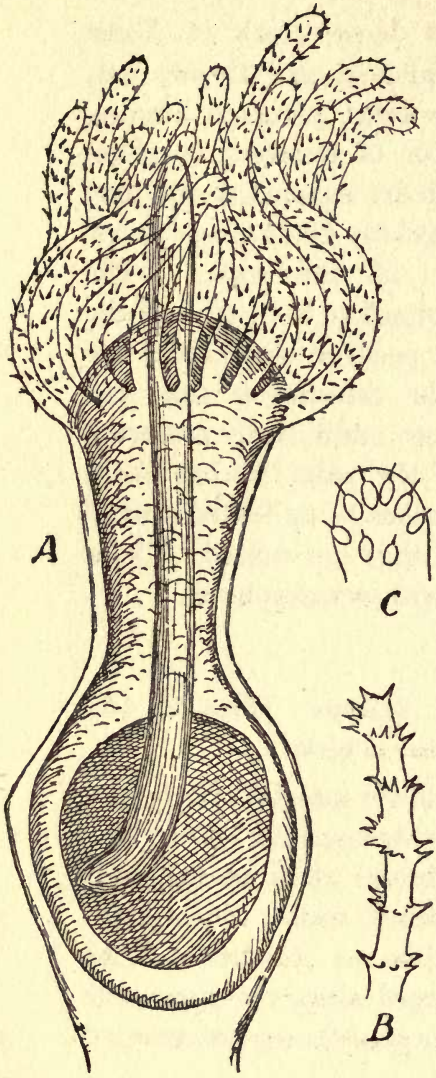


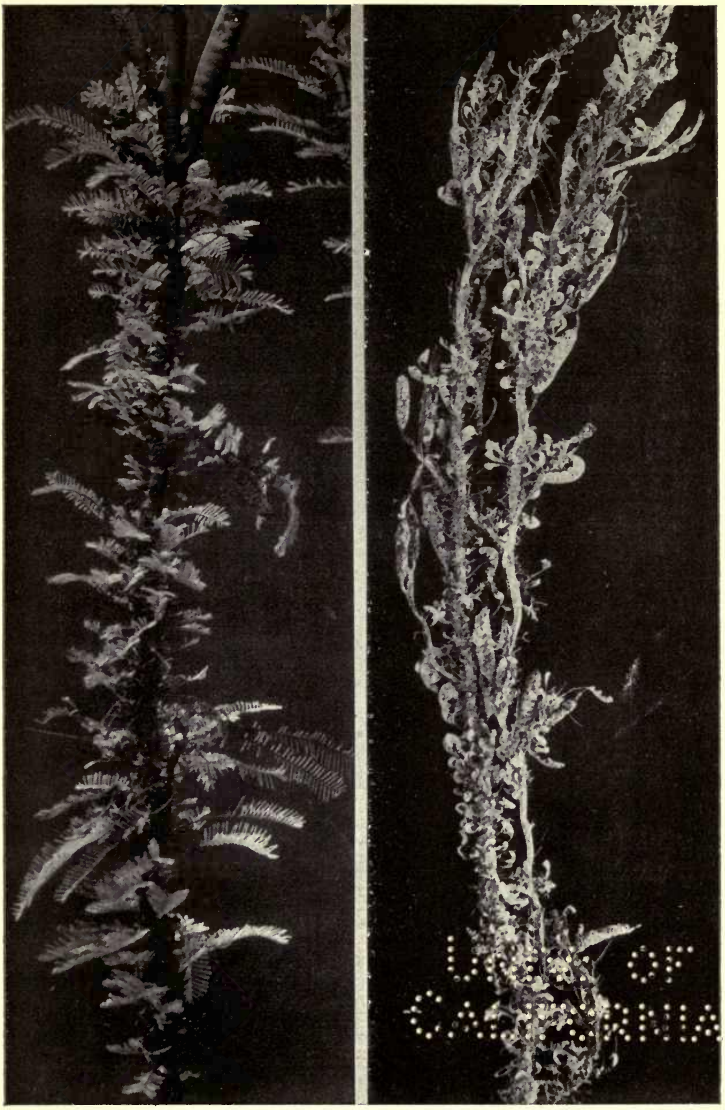
Fig. 14.—A polypite of *Plumularia pinnata* expanded and gorging a worm; also enlargements of tentacle and dart cells *in situ*. Enlarged.

(a).—The polypite.

(b).—A portion of a tentacle. Much enlarged.

(c).—Eight dart cells, *in situ*. Magnified.

The first operation on the part of the polypite was to throw out a number of darts, and then to get the tail end of the worm between the tentacles and gradually draw it down into the stomach. Owing to the mucus on the body of the worm, the darts did not appear to affect it much, and after the lapse of half-an-hour, it was still living, although its tail end was probably being digested in the stomach of the polypite.



LIVING. DEAD.

E. C. *Photo. ad nat.*

Aglaophenia pluma, Linnæus.

On stems of *Halidrys siliquosa*.

(Both half nat. size.)

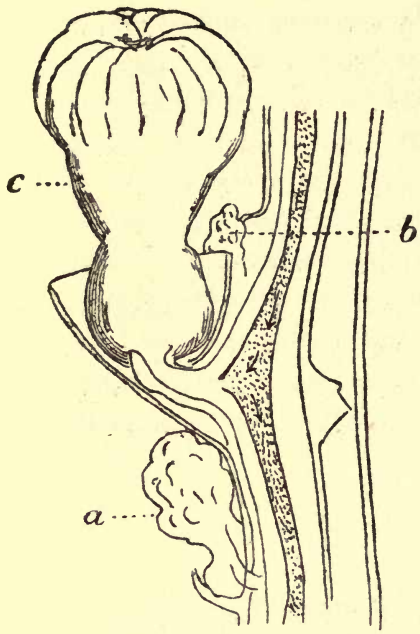


Fig. 15—

(a).—A polypite of *Plumularia pinnata* (enlarged).

b).—Showing amœboid bodies ("nematophores.")

(c).—Polypite.

together on the main stem. They are somewhat pear-shaped and lobed lengthwise, and project more or less into spines in the upper part. Hinck's description of this species appears to be rather too restricted. There is some difference between the deep sea and the shore forms, and he probably gave more attention to the former variety. In the beautiful specimen of the shore variety exhibited, several joints occur between the polypites; and the nematophores are more generally distributed than one would expect to find from Hincks' description. In

the shore variety, there is one nematophore above and one below each polypite, and in many cases, either one or two in the axils of the branches. There seems also to exist considerable variation in the development of the capsular spines, so that one can hardly help recognizing the close connection of the three species, *pinnata*, *echinulata*, and *similis*. A rather poor specimen of the deep sea form is exhibited. This form is somewhat rare, but the shore variety is common in rock pools from mid to low tide.

Plumularia setacea, Ellis.

1 specimen in liquid on *Antennularia* stem.

SPECIMEN 81. Extremely delicate, branches at a less open angle than the last species; the capsules are elongated spindle shape, quite distinct from other forms, and are produced in the axils. They are decidedly the best specific character Nematophores plentifully distributed. Rare at Hastings. Not observed as a shore form.

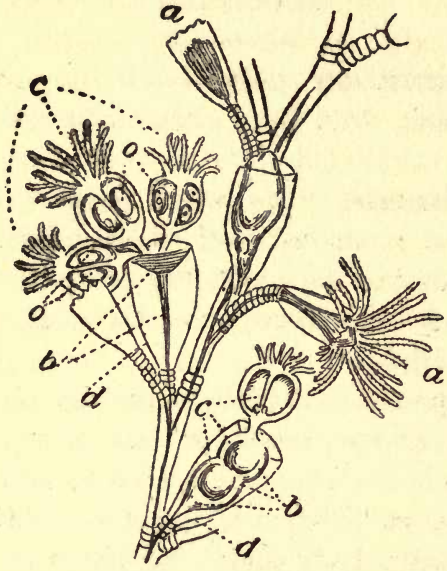


Fig. **16**—*Gonothyræa Lovéni*, Allman. Enlarged. (After Hincks).

(a).—Alimentary polypite.

(b).—That which represents the "select" polypite.

(c).—The "reproductive" bud in various stages of maturity, the most matured containing ova. In this case it fails to become detached.

(d).—The horny receptacle, or "capsule."

(o).—Ovum.

GLOSSARY.

Alimentary polypite. The polypite whose only duty is to obtain and assimilate food.

Athecata. The word means "sheathless," and is applied to the Lower Division of the Hydroida, in which the polypite is not protected by a horny receptacle, as in the Higher Division.

Capsule. Strictly speaking, the well formed horny receptacle or case which encloses in the Thecaphora all that represents the "select" polypite, together with the reproductive buds containing the ova. It is often applied to the whole body thus represented.

Cœnosarc. The word means "common flesh," that is, that portion of the compound animal structure, in the Hydroids, which is common to, or which connects, the individual polypites.

Gonophore. The reproductive bud with its envelope, as occurring in the Athecata, and where it is distinct from the polypite or bud which bears it.

Nematophore. The word signifies "thread-carrier," in allusion to the threads, or tubes of the darts with which the nematophores are often associated. They are peculiar amœba-like bodies (sometimes called "guard-polypites"), and are found associated with polypites, and also on the stem and branches in the Plumulariidæ.

Planule. The larval form into which the egg, after segmentation, develops, prior to its transformation into the polypite.

Reproductive bud. Special egg, or seed-bearing buds.

"Select" polypite. Certain of the alimentary polypites told off to bear the special reproductive egg-producing buds, and which are generally more or less modified in consequence.

Thecaphora. The word means "sheath-bearer," and is applied to the Higher Division of the Hydroida, in which the polypites are provided with a horny receptacle.

ANNOTATIONS

— Made by P. R. in —

"A History of British Hydroid Zoophytes,"

— by —

THOMAS HINCKS, B.A.

While looking through some of Mr. Rufford's books, I have been much interested in perusing the annotations made by him on the pages. Many of the remarks are exceedingly brief—simply three or four words—others are of the nature of a short sentence, while a few are somewhat lengthy. A very large number occur in the "Manuel de Conchyliologie," they do not, however, bear directly upon the Conchological section, p. 107, *et seq.* in this book. Those which are of most interest at the present moment, are written on the pages of Hincks' "History of the British Hydroid Zoophytes." I have thought that several of the more important annotations may prove of interest to the general reader as well as of value to the student of Hydromedusæ. It has been necessary to quote from the text of Hincks' work somewhat extensively, but only so much as to preserve a continuity of idea, and to show the application of P. R.'s remarks.

Page XI., line 12 *from the bottom.*

Concerning Thread-cells in Ectoderm of Cœnosarc and Gonophore, Hincks writes: "The thread-cell is a most interesting piece of structure. . . . . Two kinds of thread-cell are often met with on the same species. Besides

the formidable instruments with which the tentacles are armed, large, bean-shaped cells are sometimes crowded together in immense quantities, as, for example, in the ectoderm of the cœnosarc in *Hydranthea*, and in the outer covering of its gonophore. It is difficult to imagine what relation these can bear to the economy of the animal."

To this Mr. Rufford adds the following:

"The thread-cells on Ectoderm of Cœnosarc and Gonophore may be of service when some member of colony is defunct; as I have frequently seen Infusoria, etc., invade the space between Cœnosarc and polypary, having obtained access through the decay of one or more polypites. In some cases, however, I believe the decaying end is closed." P. R.

Page XIX., line 9 from the top.

"In the genera *Hydractinia* and *Podocoryne*. . . . some curious appendages occur in addition to the alimentary polypite. . . . We have first the spiral bodies."

These Mr. Rufford designates as "Snake-like zooids in *Hydractinia*."

The place of development of these appendages, and the energy they display is then described in the text. At the end of this paragraph "They usually form a somewhat dense fringe round the mouth of the shell [which is almost always* tenanted by a Hermit crab], and are roused from

*The words "almost always" are underlined with pencil.

their state of quiescence by anything that may irritate the surface of the Cœnosarc," this marginal note appears:

"Is there any exception? and what evidence is there that the crab has not just left the shell?" P. R.

Page XXI., first 25 lines.

In the margin at the side of the section dealing with the reproduction of a Hydroid colony; the following is written:

"In Thecaphora, buds reproductive spring from Cœnosarc and are protected. In Athecata, buds usually developed on body, but sometimes on Cœnosarc, and are unprotected." "Buds borne on special zooids which become atrophied and then resemble the capsuled gonophores of the Thecaphora."

The latter note is more of the nature of a summary of a portion of the text, than the expression of a new idea. It is, however, instructive and interesting.

Page 24, line 14 from the top.

With reference to the habit of *Hydractinia echinata*, Hincks states that it occurs on univalve shells tenanted by Hermit crab. A marginal note states:

"Also on the claws of lobster." P. R.

This is probably a unique, or at least, unusual, situation for *Hydractinia echinata*.

Page 103, line 5 from the top.

Appended to the habitat of *Garveia nutans*, is the following footnote:

"Hastings.* Polypite (wholly) and cœnosarc carrot-red, Polypary transparent, colourless (like water), more or less faintly annulated. Branches wriggling and springing from stolons entwined on stems and branches of *Hydrallmania*. No gonophores. End of March, '95." P. R.

Page 119, *line* 12 *from the bottom.*

Tubularia coronata, Abildgaard.

The following appears in the margin of p 119:

"This species appeared suddenly on the Hastings shore in the latter part of 1897, and was very abundant, but a storm about the end of the year destroyed all the colonies.—I obtained some of the gonozoids which were shed, in a glass vessel, without persuasion. They were very inactive, not knowing whether to stand on their base or on the tentacles, but rather preferred the former. Alternate tentacles were raised or lowered, The tentacles are knobbed. (p. 120). In the Hastings specimens, there appeared to be very little

* Signifies that Mr. Rufford had discovered this species in Hastings district. Three specimens in liquid are exhibited in Hastings Museum, see also p. 48.

branching, if any. I never saw this specimen here [*i.e.*, at Hastings] before." P. R.

"N.B.—The knobbed tips to tentacles of gonozoid fixed it as this species."

For illustration and description of this species see plate II., Fig. 10, and pages 49-53 of this volume.

Page 295., *line* 10 *from the top.*

Plumularia pinnata, Linnæus.

"Shoots clustered, *tall, white, or of a pale horn-colour*," etc., etc., Hincks. Marginal note:

"I have found some specimens a bright yellow to orange. Here and there, however, the ends of pinnæ were colourless." P. R.

Ibid, line 3 *from the bottom.*

"The calycles of *Plumularia pinnata* are only separated by a single joint, those of *Plumularia setacea* by two." Hincks. An asterisk at the word "joint," draws attention to the following footnote:

"Not always, by any means, in the *shore variety* at Hastings, although it holds good, to a great extent, with the deep sea form." P. R.

Hincks, continuing the description of this species remarks (p. 296, line 7 from the top): "A much safer criterion (as regards distinctive marks of the species) is to be found in the nematophores, which are scantily developed and exhibit a very peculiar structure."

"This will not hold good, either, for the shore form at Hastings (specimens with well matured gonophores) shows a nematophore above and one below each polypite, and often

This does not appear to accord with Mr. Rufford's investigations, as the following footnote on the same page indicates.

one or two in the axils of the branches. Moreover, there is considerable latitude in the degree in which spines are developed on the gonophores." P. R.

Also in the letterpress of the same page (line 13 from the top) it is stated: "When present, the reproductive capsules afford another good specific character;" Mr. Rufford's observations had led him to regard the reproductive capsules as "the best" specific character, and noted such in the margin (line 9 from bottom), he also added,

"The deep-water specimens are of the larger size . . . . and differ in other respects."

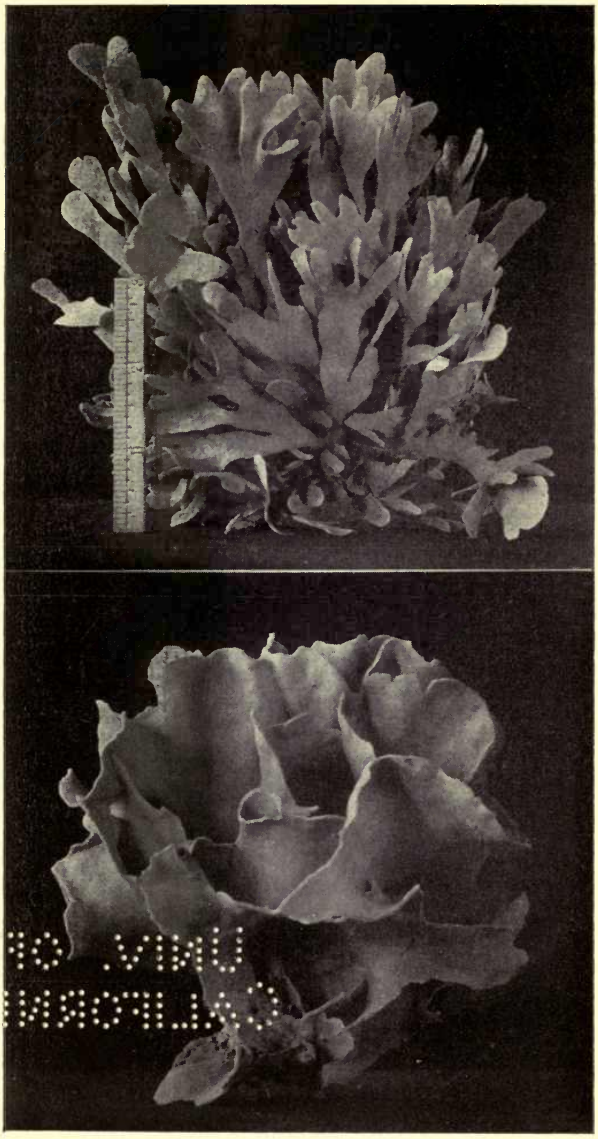
There are a few other marginal comments, such as "common in trawl," "on other Hydroid stems," and numerous summaries of paragraphs, which, however, would serve no useful purpose if quoted.

E. G.

PART III.

NOTES ON

POLYZOA, OR BRYOZOA.



E C. *Photo. ad nat.* 2.

1. A typical Polyzoon. *Flustra foliacea*, Linnæus.
(Half nat. size.)

2. A typical Bryozoan. *Lepralia foliacea*, Ellis and Soland
(One-third nat. size.)

PART III.

— AN —

INTRODUCTION

— TO —

POLYZOA, OR BRYOZOA.

SUB-CLASS I.—ECTOPROCTA.

Anus outside Tentacle stage.

Order I.—**Gymnolæmata (Holobranchiate).**

No Epistome. Tentacle stage circular.

Sub-Order 1—Cyclostomata.

* Cell mouth circular, no door (operculum).

Sub-Order 2—Cheilostomata.

Cell mouth with lip-like door.

Sub-Order 3—Ctenostomata.

Mouth of Cell cut into narrow segments closing aperture.

Order II.—**Phylactolæmata (Pterobranchiate).**

With Epistome, tentacle stage with arms.

SUB-CLASS II.—ENDOPROCTA.

Anus within the tentacle stage. No Epistome. Tentacle stage an imperfect circle.

* Cell or zoœcium.

The word Polyzoa signifies an association of animals. The group are thus termed on account of their habit of forming extensive colonies, by a process of budding, such buds being permanently retained in organic connection.

Form of Polypide. The Polypide, or Zooid, as the individual Polyzoon is variously termed, is minute, and may be generally described as having a body more or less oval in form, consisting mainly of a body-wall, and an alimentary canal suspended within it. With the exception of a few not altogether undoubtful forms in Entoprocta, the polyzoa are capable of withdrawing inwards one end of the body, thus forming a kind of funnel, at the bottom of which lies the mouth; and around it are arranged ciliated gill-tentacles. These tentacles, when the retractile end of the animal is thus withdrawn, lie within the funnel-shaped depression, and it is therefore known as the tentacle sheath. The mouth leads into a tube which is a prolongation of the funnel wall, and represents the œsophagus, or commencement of the alimentary canal.

Alimentary canal. From a point, either just outside (Ectoprocta), or just within (Entoprocta), the tentacle stage, there arises another tubular extension of the funnel, or body-wall, pendant and parallel with the other tube. This corresponds with the intestine and stomach, and united to the other tube at the supposed free ends, forms with it the complete alimentary canal, commencing with a mouth and terminating in an anus.

Tentacle stage circular. The alimentary canal is therefore suspended like a loop from the bottom of the funnel, or anterior end of body. In the great majority of the Polyzoa, the tentacles are arranged in a circle around the mouth (Holobranchia), but in some, mostly from fresh water, the circle is not complete, but side arms are thrown out, the tentacle stage then taking the form of a horse-shoe with the ends more or less prolonged (Pterobranchia).

Body cavity. Between the body-wall and the alimentary canal is a space called the body cavity. This is filled with a transparent

fluid containing corpuscles, which, probably, subserve excretion. In some instances part of the cavity is ciliated.

Body-wall structure. The structure of the body-wall is as follows : The outer layer is a horny cuticle (Ectocyst), and is secreted by an inner layer of cells (Epidermis, or Endocyst). Next come two layers of muscular tissue (Parietal muscles), the first arranged circularly and the other longitudinally. Finally, there is lining the whole of the body cavity, including the exterior of the alimentary canal, an unequal layer of cellular tissue (Cœnosarc or Parenchyma) from which are derived the parts which connect the various members of the colony. In some of the Polyzoa (Cyclostomata and Cheilostomata), the external layer of the body-wall is strengthened by a shelly deposit, and, in a few instances, it is gelatinous. The obsolete word cell is applied here to this protective outer covering, as simpler than the accepted term Zoœcium.

Alimentary canal structure. As regards the structure of the Alimentary canal, it is lined internally by an epithelium of

ciliated cells (Endoderm), and externally by the cœnosarcal layer (Ectoderm), which also lines the body cavity. There appears to be also an intermediate layer of a muscular character.

Nervous system. The nervous system is represented by a single or bi-lobed ganglion (collection of nerve-cells), situated on the wall of the œsophagus, within the body cavity, and upon the anal side. It sends out nerves to the tentacular crown, œsophagus, reproductory organs, and elsewhere.

Muscles. The chief muscles are the Retractor muscles for withdrawing the mouth and tentacles within the sheath ; the muscles connecting the stomach with the body-wall (Gastric muscles); the muscles connecting the base of the stomach with the body-wall and termed the Funiculus. Lastly, the muscles which line the body-wall, (Parietal muscles), used for reducing the capacity of the body cavity and thus everting the mouth and tentacles. The muscles are of a very rudimentary character, being single and barred, and when relaxed hang loosely like threads of cotton.

Reproduction. There are two methods of reproduction obtaining, one method asexual, the other sexual.

Asexual reproduction. The asexual method, or process of producing permanent buds, results in the formation of colonies (**colony budding**), each bud being connected with its parent by a thread or network of threads derived from the cellular layer of tissue lining the body-cavity, and by the protective cuticle and its epidermis. In a few instances, the body-cavities of adjoining polypides are openly connected. In many cases, the polypide cells of a colony are more or less distant from one another, each polypide being connected by a stem-like prolongation (Stolon). In other cases the polypide cells abut upon one another more or less compactly. Colonies are formed either over running objects, adhering to them, such as shells, stones, seaweed, etc., or growing erect and branching, thereby producing plant-like structures, with either cylindrical or laminar stems and branches. In the families ***Selenariidæ*** of CHEILOSTOMATA and ***Cristatellidæ***

of PHYLACTOLÆMATA the colonies are locomotive, the former moving by the aid of "Vibracula," and the latter with a creeping motion.

Loxosoma non-colonial. In *Loxosoma* (Endoprocta) we have the only known *single* Polyzoon. In this genus, buds are formed, but detach early. It is found commensal on marine worms.

Besides the colony budding, buds called "Statoblasts" are formed on the Funiculus and detached, being set free only on the decay of the Polypides.

Sexual reproduction. In the sexual method of reproduction, each individual possesses both male and female elements. These are situated within the body-cavity, the ovaries on the body-wall in the upper part of it, and the male cells on the Funiculus. Both elements are formed by a modification of the cells of the cœnosarcal layer lining the cavity. In only a few species does there appear to be any exit from this cavity It is therefore inferred that fertilization usually takes place within it. At the same time, it is has been

observed that the elements often come to maturity at different periods. It is likewise inferred that the embryo only escapes after the break up of the Polypide. In *Alcyonidium* there occurs an " intertentacular pore," and in *Pedicellina* and *Loxosoma* there have been discovered ciliated tubes (? nephridia) connecting the body-cavity with the exterior, and evidently subserving excretion.

Ovicells in Cyclostomata. In one group of the Polyzoa (CYCLOSTOMATA), the Polypide cells become modified into special chambers (Ovicells), for the rearing of the embryos.

Ovicells in Cheilostomata. In another group (Cheilostomata), there occurs at the head of the Polypide cell an inflation of the cell-wall, forming a recess of the body-cavity, in which the embryos are lodged during maturation. It is termed an Ovicell.

The forms and markings of these Ovicells are very good guides for specific determination.

Operculum in Cheilostomata. In the same group of Polyzoa (Cheilostomata), the mouth of the Polypide cell is furnished

with a horny door or valve (operculum) for closing the entrance, and somewhat resembling a lip. Hence, the name of this group Cheilostomata, signifying "lip-mouthed." This door (or operculum) plays an important part in the economy of this group, since it gives rise to two very curious and interesting modifications, *viz.*, the Bird's-head organ and the Vibraculum.

Operculum in Ctenostomata. In another group (Ctenostomata), the margin of the cell mouth is cut into numerous fine segments, like the teeth of a comb. When the tentacles of the animal are withdrawn, the points of the segments meet overhead so as to close the aperture. The word Ctenostomata means "cut-mouthed" in allusion to this form of operculum. An analogous contrivance may be found in the operculate Hydroids.

Avicularium. In certain of the Polyzoa (Cheilostomata), there occurs an organ called the Bird's-head organ (Avicularium), since in its higher form it resembles very strikingly the head of a bird. It is a peculiarly interesting example of modification, and one

in which the ultimate results attained are so utterly unlike the origin, that were not all the various stages of evolution traceable, it would have appeared incredible that this organ should have originated, as it has done, in the ordinary Polypide and cell. To describe, then, briefly, this peculiar organ, which occurs only in that group of the Polyzoa in which is found the lip-like door, *viz.*, the Cheilostomata.

In examining (with the microscope) the colonies of certain species, some members are found to differ somewhat from the ordinary members. The cell becomes gradually reduced in size and the aperture with its door becomes larger in proportion to the cell area, and also modified in form, approaching somewhat to the shape of a bird's beak. The size of the cell becomes still further reduced until it is quite small comparatively with an ordinary cell. The cell outline now becomes partly or wholly obliterated, and the cell commences in consequence to lose its identity as a distinct cell, and gradually becomes merged in a neighbouring one. The Polypide has become aborted, but well-developed muscles occupy its former position. These serve for opening

and closing that which was formerly the door of the cell, but which is now more appropriately termed the mandible, since it is seen to be continually opening and shutting, with a sharp snap, and often with some minute creature in its grip. It seems probable, therefore, that the function of this organ may be to protect the colony from hostile intruders.

Vibraculum. There is yet another departure, a further modification of the Bird's-head organ, to be described. It consists in a further development of the mandible, and its adaptation, evidently for a different purpose from that of prehension. The mandible becomes greatly prolonged, to such an extent that it has more the appearance of a sword or stick, guarding the various members of the colony with which it is associated. The idea is borne out by the circumstance that this sword or Vibraculum, as it is called, is constantly waving from side to side. If this vibracular organ be now compared with its point of departure, *viz.:* the Polypide and cell, one can hardly fail to be struck by the

wonderful plasticity of nature, as evidenced in this example of the specialization of the individual.

Epistome. There is one organ which has hitherto not been described, since the majority of Polyzoa are distinguished by its absence. This organ is the "Epistome," a hollow lobe of the body-wall, overhanging the mouth upon the anal side. It is ciliated and appears in one marine species to aid the animal in ascending its tube, thus performing a function similar to that of the molluscan foot, of which it is regarded the precursor. The group of the Polyzoa in which the epistome occurs is called the Phylactolæmata.

Classification. The three most important distinctions in the Polyzoa are :

1.—Whether the anus lies outside (Ectoprocta) the tentacle stage, or within it (Endoprocta).

2.—Whether the organ known as the Epistome be absent (GYMNOLÆMATA*), or present (PHYLACTOLÆMATA†).

*Signifies "naked-throat," *i.e.*, without epistome.
†Means "throat-guarded," *i.e.*, with epistome.

3.—The form of the tentacular stage, *i.e.*, whether it be circular (Holobranchia) as in the GYMNOLÆMATA, or like a horse-shoe (Pterobranchia), as in the PHYLACTOLÆMATA.

Considerations 2 and 3 concern the Ectoprocta.

The Entoprocta are few, and of rather doubtful position as regards the Polyzoa. In them there is no Epistome, and the tentacle stage is neither a complete circle nor thrown out into arms.

In some species (*Loxosoma*), there is a pedal gland comparable to the peduncle in the Brachiopoda.

Affinities. The Polyzoa appear to be cut off by absent forms from very near ancestors. Perhaps the nearest approach to their structure is to be found in the ROTIFERA, which are microscopic water animals, sometimes single, sometimes compound, and either fixed or free. At the oral end of the body there is a ciliated disc, capable of withdrawal. They have an alimentary canal and anus, a bladder and water vascular system. There is also a

distinct body-cavity, and the individuals are unisexual instead of bisexual, as in the Polyzoa.

PHRONIDEA and BRACHIOPODA. Above the Polyzoa in point of structure the PHYLA PHRONIDEA and BRACHIOPODA, are placed. In these, the chief point to be noted is the modification of the tentacle-arms, which are coiled up and supported by an internal shelly skeleton. In addition to being organs of touch, they also subserve æration. In the BRACHIOPODA there is a ventral and dorsal shell, and the animals are never compound.

MOLLUSCA. When the Polyzoa are compared with the Mollusca proper, it is found that the latter, with their well-formed heart, extensive nervous system, and several other features, are so far in advance that the gap is remarkable. It can hardly be doubted, however, that there are in the lamellar gills, and foot of the bivalve mollusc, the homologues, respectively of the tentacular crown, and the epistome of the Polyzoa.

P. J. R.

TABLE D.

Systematic Table to show the Classification

— OF THE —

PHYLUM POLYZOA.

Class I.—ECTOPROCTA.

Anus outside the tentacular circlet.

Order. I.—GYMNOLÆMATA.

Ectoprocta with circular lophophore, without epistome.

Sub-order 1—Cheilostomata.

The orifice of the zoœcium can be closed by an operculum. Avicularia, vibracula, and ovicells, are often present.

Tribe A.—CELLULARINA. 8 Families.

Tribe B.—FLUSTRINA. 4 Families.

Tribe C.—ESCHARINA. 12 Families.

Sub-order 2—**Cyclostomata.**

Zoœcia tubula, with a plain terminal orifice without operculum. Without movable appendages. The ovicells are modified zoœcia.

TRIBE A.—ARTICULATA. 1 Family.

TRIBE B.—INARTICULATA. 4 Families.

Sub-order 3—**Ctenostomata.**

When the tentacle-sheath is retracted, the orifice of the zoœcium is closed by a folded membrane as by an operculum. Zoarium never calcareous. Ovicells and appendages absent.

TRIBE A.—HALCYONELLEA. 3 Families.

TRIBE B.—STOLONIFERA. 7 Families.

Order II.—**PHYLACTOLÆMATA.**

Fresh-water Polyzoa with horse-shoe-shaped lophophore and epistome.

FAMILY 1—CRISTATELLIDÆ.

FAMILY 2—PLUMATELLIDÆ.

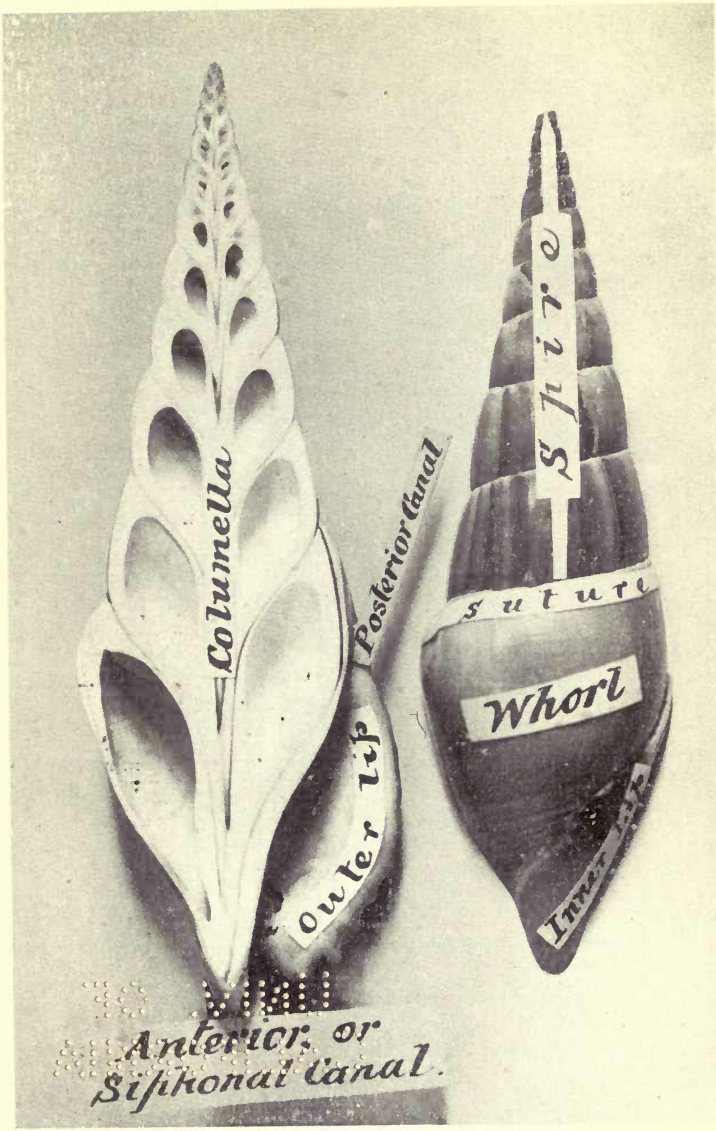
CLASS II.—ENDOPROCTA.

Anus within the tentacular circlet.

Arranged by E. G. *After* SEDGWICK.

PART IV.

CONCHOLOGICAL NOTES.



E. C. *Photo. ad nat.* *Prepared by P. J. R.*

Immature Shell of

Rostellaria curvirostris, Lamarck.

Median longitudinal division.

Portion of spire missing.

(Nearly nat. size.)

PART IV.

CONCHOLOGICAL NOTES.

Although the plates (Nos. XII.-XVII.) contained in this part are more or less self-explanatory, they appear to require a few notes in further elucidation of the specimens they illustrate. It may also be acceptable to the reader if a reason is stated for their introduction.

For some time prior to his decease, Philip James Rufford directed his energies to the preparation of several series of type specimens of shells, each of which illustrates some special feature in the structure of molluscan coverings.

In so doing, he recognized, and exemplified the dictum, that if a Museum is to fulfil its highest purpose as an educational factor, every exhibit, or group of exhibits, must be employed as an object lesson.

With this plan in view, he had arranged, and labelled many specimens, in a manner best calculated to arrest the attention of an observer, and direct it towards any special point in the construction of the abode or the anatomy of the animal producing and inhabiting it; and it has been thought that these series are of sufficient importance to merit the notice of all persons interested in such work. They may also serve as ensamples to any naturalist contemplating the formation of similar series. They must not be regarded as exhaustive and final, nor complete in every detail. An exhibition on a scale such as will allow the introduction of each characteristic of the structure, growth, peculiarities, etc., of Univalve, Bivalve, and Multivalve shells, requires a very large number of specimens, embracing world-wide distribution of species; many months of labour to name, label, and arrange in systematic order; and also ample accommodation for effective exhibition. Such is not expected in a provincial Museum.

The specimens are exhibited in one of the table cases in the Hastings Museum. There is little doubt that the arrangement in which they now appear was not intended as final; additions would have necessitated various alterations of positions. Among the additions intended were univalve shells in sections, showing such features as the columella, the sutures, the whorls, the inner and outer lips, and also the anterior and posterior canals. One such specimen is illustrated in plate XII. It is exhibited in the same case as the other descriptive shells.

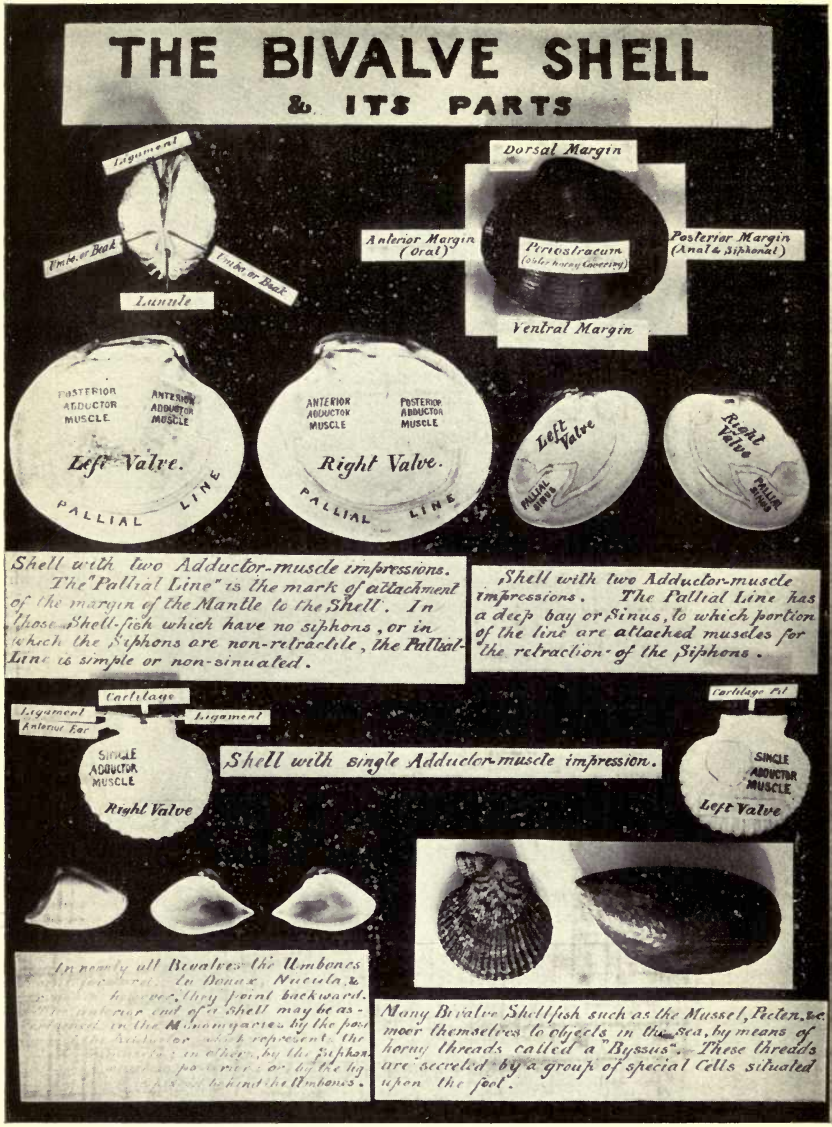
The anatomy of molluscan animals was also receiving treatment, two creatures having been mounted in preservative fluid in glass museum jars. The animals producing **bivalve** shells are represented by the animal of *Anodonta cygnea*, Linnæus, the fresh-water Mussel, deprived of its valves, and so displayed as to show the mantle, mouth, foot, gills, and other organs, in an interesting and instructive manner.

The other specimen is the animal of *Buccinium undatum*, Linnæus, the Common Whelk, illustrative of the **univalve** group. It has been most cleverly treated and arranged. Deprived of life while in the act of crawling, various portions of the body—the proboscis, syphon, tentacles, etc.—are fully displayed in a very natural manner, allowing the anatomy of the creature to be easily observed and studied.

Upon the exterior of the jars small labels are affixed, each label having a slender prolongation, terminating at the part named.

It has been thought that these, as also the series of shells, on account of the educational value of both, are worthy of reproduction in the present work.

The circular shape of the jars, unfortunately, detracts somewhat from the distinctness of the objects and the lettering.



E. C. Photg. ad nat. Prepared by P. J. K

The Bivalve Shell, and its parts.

Showing the Margins, Ridges, Umbones, Ligament, Linula, Ears, Accessory Plates, and the Periostracum.

(All one-third nat. size.)

PLATE XIII.

The Bivalve shell, and its parts.

Some of the principal lineaments of a Bivalve shell are the dorsal, ventral, anterior, and posterior **margins; ribs, ridges,** and **spines;** the **umbones;** the **ligament;** the **linula;** projecting portions known as the **ears;** the **accessory plates;** and the **periostracum.**

The **Margins** determine the contour of the valves. They are clearly shown in fig. 8.

The **Ribs** radiate from the umbones to the anterior, posterior, and ventral margins, figs. 4, 4a, plate XIV.; the **Ridges** are arranged in concentric form, and coincide with the lines of growth, they can be seen in fig. 1; **Spines** vary greatly in length, thickness, and shape, some are slender and pointed, others narrow, thin, long, flat, or, plicated, and project at various angles. The **Umbones,** fig. 1. The umbo of each valve originates as the embryonic shell, and forms the point from which the growth of the valve proceeds.

The **Ligament,** figs. 1, 3, is an elastic structure, consisting of two parts, an external horny substance, and an internal substance of very similar character, known as the **Cartilage,** both of which act as a hinge, and hold the valves together. Figs. 3, 3a, and plate XIV.

The **Linula** is a part usually oval in outline, in the form of a depression in front of the umbones, fig. 1.

The **Ears,** figs. 3, 3a, 5, are known as anterior and posterior. They are elongated portions of the dorsal margin of the valve.

Accessory plates are small valves which protect the dorsal margin. In the common Piddock (*Pholas dactylus*), the number is five.

The **Periostracum,** fig. 8, is the horny cuticle, or so-called epidermis. It is secreted by the free edge of the mantle. It varys considerably in thickness; on some shells it is thin and soft, on others thick, coarse, or drawn out into long, beard-like filaments. It protects the shell from the action of erosive chemical substances, and the adverse conditions of weather.

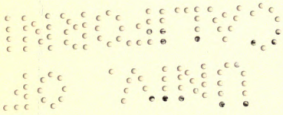
The important internal features of a bivalve shell are the anterior and posterior **adductor** muscle impressions; the **hinge-teeth;** the **pallial line** and **sinus.** In several genera of the BRACHIOPODA (which have recently been isolated as a distinct PHYLUM) there is a **branchial skeleton,** which, when in the form of a loop, is supported by a calcareous process of the dorsal valve; but as a spiral form it is devoid of a support.

The **Muscle impressions** indicate the points of attachment of the adductor muscles. These muscles pass through the body transversely, and by contraction, keep the valves closed at the will of the animal, during which time the cartilage is compressed. When the tension is relaxed, the valves gape by reason of the expansion and counter-action of the cartilage.

The **Hinge-teeth.** These are of two kinds. The **cardinal** teeth, which are situated immediately beneath the umbones, and those on either side of the cardinal, named the **lateral.** Figs. 4, 4a, plate XIV.

In the genus **Arca,** the teeth are very numerous, 35—42; in many other genera (**Pecten Ostrea,** and others), they are absent.

The **Pallial line,** and the **Sinus,** figs. 2, 2a, 7, 7a. The former is the line of attachment of the pallial muscle of the mantle-edge to the shell, the curve (the sinus) in its outline, is known as the pallial bay, or indentation, and it permits the syphons, when retracted, to be contained within the closed valves.



E. C. *Photo. ad nat.* *Prepared by P. J. R*

The Cartilage, and its arrangement; and The Hinge-Teeth.

(All one-third nat. size.)

PLATE XIV.

The Cartilage, and its arrangement; and The Hinge-Teeth.

The cartilage of Scallop and Oyster shells is in the form of a triangle, with the apex directed towards the umbo. It is of a resilious nature, but when dry, exceedingly hard and unyielding. It varies considerably in shape, size, and the position it occupies. See also descriptive labels in the plate.

"The 'Ligament' is a thin horny, inelastic band connecting the hinge of each valve; it is wedged within a cleft in the Shell and is often more or less connected with the 'Cartilage.' The 'Cartilage' is of a somewhat similar substance, but is thick, compact and fibrous, and occupies a 'pit.' Its action is to keep the valves open, in opposition to the Adductors. It differs chemically from the 'Ligament.'"

Figs. 1, 1A.—Valves of *Pecten*. "In Pecten the Ligament runs the whole way along the hinge-line, the Cartilage being central.

Figs. 2, 2A.—Valves of *Anomia*. "Cartilage carried upon a process."

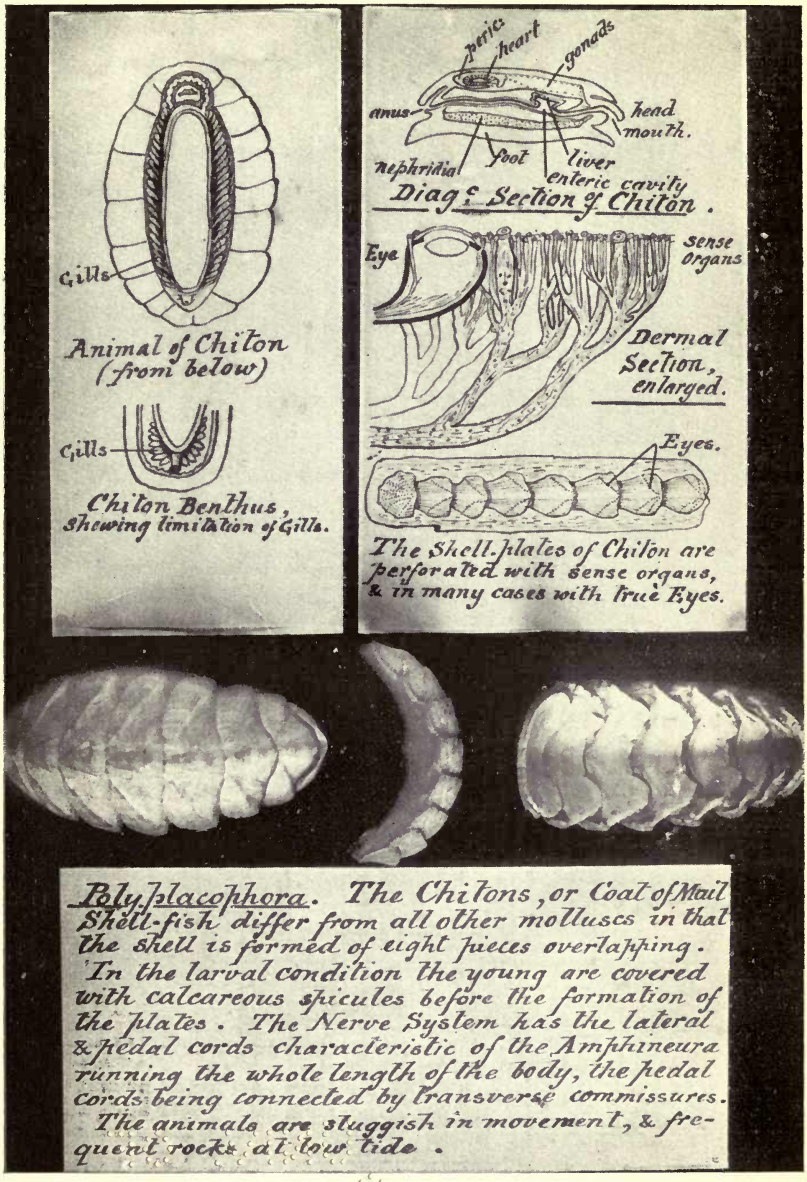
Figs. 3, 3A.—Valves of *Ostrea*. "In the Oyster there are no Hinge-teeth."

Figs. 4, 4A.—Valves of *Cardium*. "Lateral teeth, Cardinal teeth."

Figs. 5, 5A.—Valves of *Pholas*. "In Pholas there is no Cartilage."

Figs. 6, 6A.—Valves of *Tellina*. "Cartilage-shelf perpendicular."

Figs. 7, 7A.—Valves of *Solen*. "Cartilage carried upon a shelf."



E. C. *Photo. ad nat.* *Prepared by P. J. R.*

Animal, Shell-plates, etc., of *Chiton.*

(Half nat. size.)

PLATE XV..

The Animal, Shell-plates, etc., of Chiton.

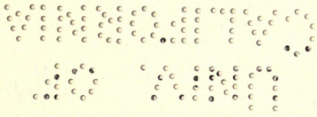
The Family of the **Chitonidæ** constitute a Sub-class of the GASTROPODA in the PHYLUM Mollusca.

The Sub-class is ISOPLEURA (PLACOPHORA).

"The Chitons, or Coat-of-Mail Shell-fish, differ from all other molluscs in that the shell is formed of eight pieces overlapping. In the larval condition, the young are covered with calcareous spicules before the formation of the plates. The animals are sluggish in movement, and frequent rocks at low tide." (P. J. R. See descriptive label in Plate opposite.)

"The shell is composed of eight transverse imbricating plates, lodged in a coriaceous mantle, which forms an expanded margin round the body. The first seven plates have posterior apices; the eighth has its apex nearly in front. The six middle plates are each divided by lines of sculpturing into a dorsal, and two lateral areas. All are inserted into the mantle of the animal by processes (apophyses) from their front margins. . . . . The border of the mantle is either bare, or covered with minute plates, hairs, or spines." (S. P. Woodward, *Manual of the Mollusca*, p. 156).

"The head is without tentacles and sense-organs. The foot occupies the greater part of the ventral surface, and has a broad, flat sole. The mantle occupies the whole dorsal surface, and completely hides the head. The visceral sac is flattened and not drawn out into a dome. The mantle-fold encloses a shallow groove which completely surrounds the body, and is roughly of uniform depth throughout. The ctenidia, which are bipectinate and projecting, are attached to the floor of this groove, generally in the hinder part, but in some forms they extend forwards nearly to the head; they vary in number from six to eighty pairs. The sexes are separate. There is only one family, but there is considerable variation in the group, both specific and individual, and consequently, a large number of species has been described." (A. Sedgwick. *A Student's Text-Book of Zoology*, pp. 387-392).



E. C. *Photo. ad nat.*

Specimens prepared by P. J. R.

SPECIMEN 1.

SPECIMEN 2.

PLATE XVI.

SPECIMEN 1.

Ventral view of the animal of the Fresh-water Mussel,

Anodonta cygnea, Linnæus.

Showing the mantle, gills, mouth, labial palps, foot, and anus.

This bivalve is a typical illustration of the Class LAMELLIBRANCHIATA, and also of the Conchological Division, **Bivalve Shells.** The MANTLE (as seen in the illustration) is the portion immediately below the words FOOT, GILLS, and above PALPS, MANTLE. It is developed on both sides of the animal, and is divided into a right lobe and a left lobe; the MANTLE indicator terminates in front of the right lobe. The mantle secretes over the whole of its outer surface, a deposit, consisting of carbonate of lime and an organic matrix known as conchyolin. In addition, there is a thick, calcareous layer, and on the exterior of each valve there is a horny cuticle, or periostracum. See plate XIII., fig. 8.

The LABIAL PALPS may be regarded as expansions of the margins of the mouth. The surface of each is thickly covered with cilia, which create currents of water carrying food to the mouth. As will be seen in the illustration, they are lobed, the median groove being very distinct.

Jaws and tooth-ribbon, or radula, are absent. The mouth is connected to the stomach by a short œsophagus. The remainder of the alimentary canal is of considerable length, and greatly convoluted, terminating at the ANUS.

The FOOT can be used by the animal to assist its movements along the bottom of the pond, or river, and enables it to bury itself in the mud. It is very muscular and powerful. Within it is contained some of the viscera. It can be protracted at will by the creature by turgescence with blood. Retraction is accomplished by retractor muscles.

SPECIMEN 2.

The animal and portion of shell of the Common Whelk.

Buccinum undatum, Linnæus.

Showing the proboscis enclosing toothed band, tentacles, eyes, syphon, mantle, foot, gill, and reproductory organ.

The Whelk is a typical illustration of the Class GASTROPODA, and also of the Conchological Division, **Univalve Shells.**

The PROBOSCIS, which is evaginable from the base, is the organ through which the food is conveyed to the stomach. At its extremity is situated the tooth-ribbon (TOOTHED BAND), or radula. This organ consists of a ribbon of chitinous or horny membrane, upon which are situated siliceous teeth of various shapes and sizes. The teeth are arranged in transverse rows, and as the front part of the radula is worn away, new teeth from behind are brought into use.* They are arranged in definite order: that in the median line of the radula is known as the *rachidian*, on either side of this, the *laterals*. The central tooth has seven cusps, the laterals, four cusps each, the marginal cusp of each lateral tooth is greatly extended and curves towards the median line. The radula bears 100 rows of teeth. The TENTACLES are two in number, each having an eye situated at the base. The EYES consist of cornea, lenses, retina, and optic nerve.

The SYPHON is a spout-like continuation of the mantle edge. It conducts water into the mantle-cavity.

The MANTLE completely enfolds the body at the junction of visceral sack with the head and foot. In one part of the mantle is a deep groove which forms the mantle-cavity, within which are the ctenidium, anus, renal orifice, and generative opening. On the surface of the mantle are the glands, which secrete the shell-producing materials and the periostracum.

The FOOT is a long, and somewhat broad, muscular creeping disk, projecting from the ventral surface of the body. Its action impels the creature in a steady gliding manner.

GILL or ctenidium. The whelk possesses but one ctenidium. It is attached for the greater part of its length to the mantle-wall, and bears a row of plates arranged perpendicularly to the axis.

The MUSCLE OF ATTACHMENT is affixed to the body at one end and to the interior of the shell at the other end. By its elongation the animal is exerted from the shell, and retracted by its contraction.

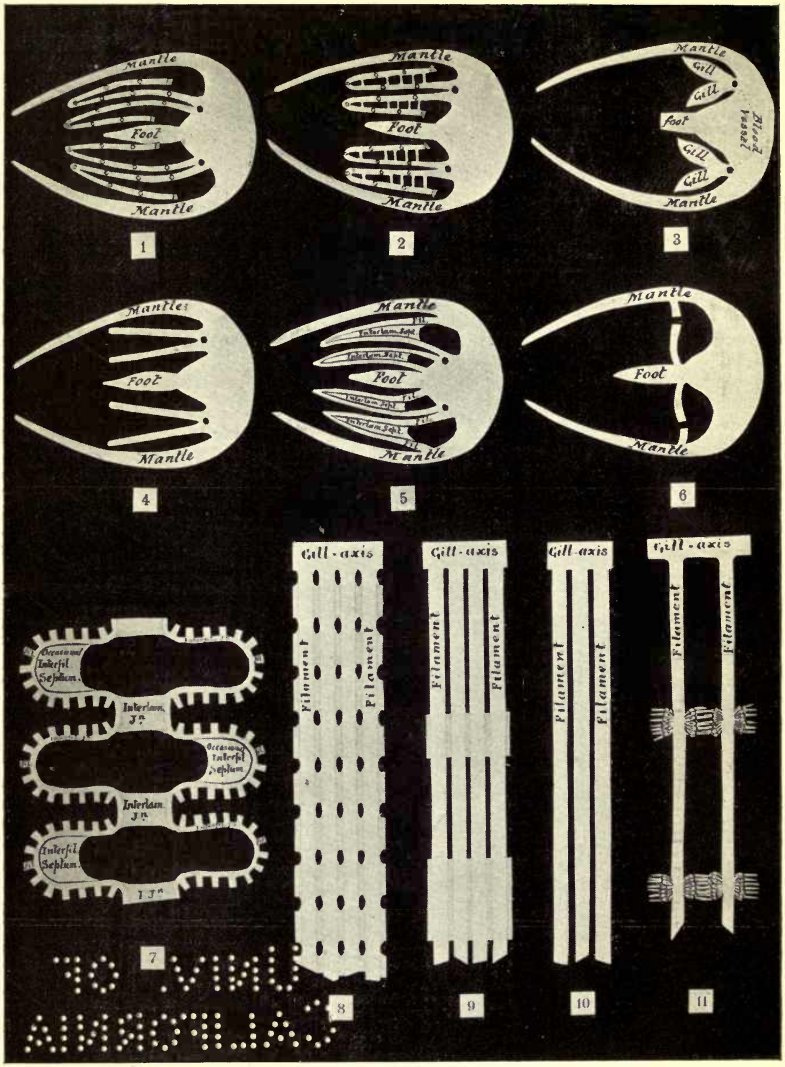
REPRODUCTORY ORGAN. The whelk is dicœcious, and there is little external indication of the sexes.

E. G.

*The whelk has but three teeth.

The *Pelecypoda*, or *Lamellibranchiata* are characterised by the absence of a head and tooth-band (Odontophore), and by the possession of a shell composed of two pieces, or valves. The Pelecypoda are classified according to Gill-structure. The Gills, or breathing organs, are composed of numerous filaments arranged parallelwise, and pendant from an axis, like the teeth of a comb. Collectively, they form plates, or lamellæ, running lengthwise of the body, there being two of such plates, or Gills, upon either side. In the lowest forms of the Pelecypoda, the filaments are straight, but in the higher types, after descending, are bent laterally upwards and nearly parallel; in many groups their ends become united laterally, whilst in others, they fuse with the adjacent parts of the body. The Gill, being thus bent, forms two nearly parallel surfaces, which are kept relatively apart by "junctions," either in the form of bars at suitable intervals, or by vertical plates, or Septa. In like manner, the filaments, in relation to one another, are either free, or are retained in perfect parallel and open order

by "interfilamentary junctions," formed of little opposing groups of cells whose cilia interlock. In the higher Pelecypoda, this form of junction gives place to horizontal bars (like those of a gate), leaving water passages of greater or lesser extent. The blood of the mollusc passes down the interior of the filament and thus is brought into close proximity with the oxygenated water, which is kept circulating over the Gills by means of the ciliated epithelium which clothes the filaments. P. J. R.



E. C. *Photo.* *Diagrams by P. J. R.*

A series of diagrammatic Sections illustrating the different arrangement of the Branchiæ in LAMELLIBRANCHIATA.

PLATE XVII.

A series of diagrammatic sections illustrating the different arrangement of the Branchiæ in

LAMELLIBRANCHIATA.

Fig. 1.—Transverse section of FILIBRANCHIATA.
,, 2.— ,, ,, ,, EULAMELLIBRANCHIATA.
,, 3.— ,, ,, ,, PROTOBRANCHIATA.
,, 4.— ,, ,, ,, *
,, 5.— ,, ,, ,, *
,, 6.— ,, ,, ,, SEPTIBRANCHIATA.
,, 7.—Showing a number of filaments attached to interfilamentary junctions (interfil. ju.), which are retained in loop form by expansions named interlamellar junctions (interlam. ju.), a part of each alternate loop being filled with occasional interfilamentary septum.
,, 8, 9, 10.—Portion of gill axis with filamentary rods.
,, 11.—Two rods with epithelial prominences, from which project rows of long cilia interlocking with others of adjacent filamentary rods.

The LAMELLIBRANCHS constitute the primary division, or Class, of the Phylum MOLLUSCA. A Lamellibranch is a symmetrical mollusc which is devoid of head and odontophore, or toothed tongue; the mantle, or covering of the body, divided into two lobes; the shell composed of two parts, or valves; and respiration, or oxygenation of the blood, is performed by lamellate gills. The name LAMELLIBRANCHIATA has been taken from the form which the gills present in most members of this Class. The Gills, or branchiæ, are projections of the body, and are usually placed in a part known as the mantle-cavity. These branchiæ take a certain form to which the term Ctenidia has been applied. Each ctenidium consists of an axis attached to the body, and bearing two rows of projecting lamellæ. These organs are an additional assistance to the general system of respiration, which, in all species of this class, is carried on through the outer surface of the body.

* I have not been able to determine these.—ED.

Each Lamellibranch possesses two ctenidia attached to the ventral surface of the body, one on either side of the foot. The ctenidia are of variable lengths. In the PROTOBRANCHIATA, fig. 3, they are very short and are attached to the surface of the body by a slender portion. The next stage, fig. 4, shows them more or less parallel, but diverging at their distal ends. The FILIBRANCHIATA, fig. 1, show a further stage in the prolongation of the ctenidia, in which they become bent upon themselves, each reflected portion taking the form of an ascending limb terminating with a free end. These ascending limbs in the EULAMELLIBRANCHIATA, fig. 2, are united at certain points by interfilamentary vascular concrescences, fig. 7., and the end of the ascending, or outer ctenidium becomes fused to the mantle, while that of the inner ctenidium undergoes concrescence with the corresponding one at the base of the foot. The interlaminar junctions produce cavities, communication with each other being effected by means of pores. In some members of this division, the gills are folded along dorsoventral lines, fig. 5, each fold including a certain number of filaments.* In fig. 6, it may be seen that the SEPTIBRANCHIATA are distinguished by a muscular septum on either side of the foot. Each septum, although perforated with pores, is continuous from mantle to foot, and completely divides the mantle-cavity into a dorsal and ventral part.

The filaments of the ctenidia, figs. 8, 9, 10, are composed of a vascular tissue enclosed within a chitinous layer, over which is spread an epithelium, which, here and there, develops epithelial prominences, from which project at right-angles to the axis of the filament, rows of long cilia. These cilia interlock with others emanating from neighbouring filaments, as represented diagrammatically in fig. 11.

E. G.

*Sedgwick. Text Book of Zoology, p. 341.

PART V.

GEOLOGICAL NOTES.

AN APPRECIATION

BY

A. C. SEWARD, F.R.S.

(Fellow of Emmanuel College and
University Lecturer in Botany, Cambridge),

Author of "Catalogue of the Mesozoic Plants in
The Department of Geology, British Museum
(Natural History).

In response to an invitation, Mr. Seward has very kindly contributed the following Appreciation of the late P. J. Rufford, and his work among the Wealden fossil plants which he (P. J. R.) found in such large quantities at Ecclesbourne, several years ago.

E. C.

My acquaintance with Mr. Rufford began about the year 1893, when I was engaged in the description and cataloguing of the magnificent series of fossil plants from the Sussex cliffs near Hastings, which he collected and afterwards disposed of to the British Museum. The name of Rufford was impressed upon my mind by the occurrence on each specimen of a label bearing the inscription "Rufford Collection." In the course of my work I frequently

met with notes attached to the fossils, which made it clear that the collector of the specimens was not one who contented himself with amassing material for others to examine, but that he was a true student who looked upon fossils as the records of past life. The value of the Rufford collection is due in no small degree to the care and discrimination with which the specimens were selected.

Mr. Rufford's suggestions, frequently made to me in the course of my work, afforded striking proof of his scientific instinct and critical faculty; he possessed in large measure the power of observation, and was accustomed to go straight to Nature for information. In looking over the material with me, during his visits to the Museum, he would occasionally miss a particular fragment of some stem or leaf; he seemed to remember each individual specimen, and recognised the supreme importance of keeping the most fragmentary and unattractive pieces as possible clues to the interpretation of larger and more perfect fossils.

It would occupy too much space were I to attempt to give an account of the nature of the plant records which we owe to Mr. Rufford's

skill and devotion. Before his collection was acquired we possessed a mere handful of samples of the vegetation of the Wealden period as it existed in Britain. Our knowledge of the plants of that epoch, of which the water-borne muds and sands now form the rocks of the Wealden area, was chiefly founded on German and other Continental material. Now we have a list of thirty-five distinct species represented in most cases by numerous and unusually complete specimens in the Rufford collection. It is true that many of these forms were previously known, but the examination of the more perfect fossils from Ecclesbourne, where most of Mr. Rufford's plants were found, enabled us to considerably extend and in many instances correct the descriptions founded on the older material. Several new types, both genera and species, were brought to light by Mr. Rufford's labours; of these I will only mention a fern to which the name of *Ruffordia* was given, and a species of Pine wood described in a paper read before the Linnean Society in 1895 as *Pinites Ruffordi*.

The following letter written soon after the publication of the second volume of the "Catalogue of Wealden Plants in the British Museum," is of interest as showing what keen interest he took in the work and how thoroughly he made himself acquainted with the various types. I should like to add how much pleasure I derived from Mr. Rufford's satisfaction with my attempt to describe his splendid collection; his veiws were always very carefully considered and it was with much hesitation that I committed myself to an opinion with which he did not fully agree.

THE CROFT,
HASTINGS.
January 27th, [1896].

DEAR MR. SEWARD,

I should have acknowledged your letter earlier, but rather waited to be in possession of my copy of the catalogue before doing so. I have now received it and heartily congratulate you on having so thoroughly balanced up accounts with the English Wealden. . . . I am more than delighted and satisfied with the way in which the collection has been described and figured. I am very pleased with the new plates, and I think they [the Museum authorities] have been generous as regards their number.

I should have liked a few more illustrations of the Cycad leaves, but covetous man will never stop! At a later period I will write to you again—when I have had time to go through the volume and when I may like to make a few things clear in my own mind.

In Pl. xix. I see you have grouped together under one name *(Pinites Solmsi)* what I have always regarded as two clearly distinct species of cones, and what I was under the impression you agreed with me to be such, Figs. 1 and 3 I have always regarded as quite distinct from 2 and 4. The bracts of the former are always round; the cone is shorter, and smaller, and more obtuse at base and apex as compared with the latter, which has a pointed bract as shewn in association with the foliage shewn in Pl. xviii., fig. 2. I have never met with the rounded form in association with the other, although the other is rather common in some parts and I have seen dozens, but have never been led to link them with the former.

Did you ever examine the spores and spore-cases of that Club-Moss (?) or could you not make anything of them? With regard to the reticulated markings on the disc of *Bennettites*, I have a specimen from which it appears that the reticulated ridges represent the spaces between and around closely packed hollow hairs. In some cases the hairs appear to have been preserved, in which case they permeate the matrix at an angle and are shewn in the centre of the mesh by a black dot or ring. In most cases, however, the hairs have apparently been destroyed when these only left the casts around the bases.

I am sending you two or three specimens that possibly may be of use to you. A small leaf-like specimen lobed at the margins, which, however, I fear is not a leaf (unless of some conifer or other), but may throw out the suggestion that it may be the dermis of a stem-scale naturally of a concave form but flattened and split at the edges??

By-the-bye, can you refer me to any papers or elsewhere where I can obtain a few clear illustrations (to illustrate cases at [Hastings] Museum) of Cycads and fruits, in fact all our series of plants? Any botanical journal that I could cut up for that purpose.

Well, please excuse such a long letter and believe me,

Yours very truly,

P. RUFFORD.

In the introduction to Volume I. of the "Wealden Catalogue," I published a Geological Coast-Section between Hastings and the Pett Levels with descriptive notes kindly contributed by Mr. Rufford (p. xvii.). I also asked him to write a few notes on the manner of occurrence and association of the various plants in the rocks of the Hastings district, and these were incorporated in the final section of Volume II. (p. 238).

Mr. Rufford was a naturalist in the broader sense of the word; his interest in fossil plants represented but one line of

activity. My own conversations with him were mostly confined to discussions on Wealden plants, but I soon discovered that he was equally enthusiastic in the identification of fossil animals, and his extensive knowledge of certain groups of living marine organisms is well known. One of the last letters which I received from Mr. Rufford contained a request for information as to facilities for working at the Naples Zoological Station.

Philip Rufford was a striking example of a type of scientific man which is far too rare ; he had a deep love for Nature, and the earnestness with which he devoted himself to the study of various branches of Natural History inspired one with admiration for his ability and respect for his love of truth.

A. C. SEWARD.

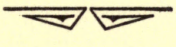
PART V.

THE GEOLOGY

— OF THE —

EAST CLIFF, HASTINGS.

PLATE XVIII.

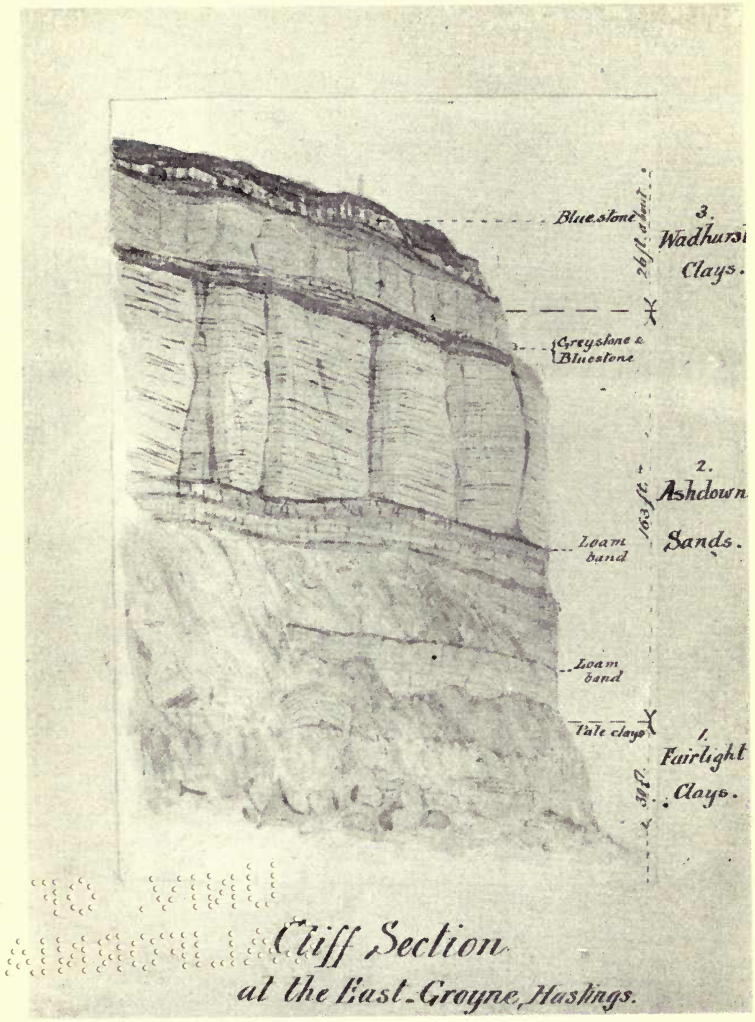


A case in the Geological Section of the Hastings Museum, contains rock specimens, collected for the purpose, and arranged by Philip James Rufford, which illustrate the Geological formation as shown in the East Cliff, Hastings.

The Formations there seen are, in ascending order,

1.—The Fairlight Clays.
2.—The Ashdown Sands.
3.—The Wadhurst Clays.

Also, a coloured diagram of Cliff section at the East Groyne. See plate XIX.



E. C. *Photo. from a water colour-drawing by P. J. Rufford.*

A diagrammatic section of the

EAST CLIFF, HASTINGS.

PLATE XIX.

FORMATION No. 1.

FAIRLIGHT CLAYS.

The Fairlight Clays form the lowest portion of the Wealden Formation, and almost the lowest beds in the Local Wealden area. There is a small patch of older beds, the Purbecks, which is exposed, on the surface, partly through upheaval, and partly through denudation, extending for some eight miles, from near Battle, through Brightling, to Heathfield; but, with this exception, the Fairlight Clays are the oldest beds short of Dorsetshire.

Their most extensive development is beyond Fairlight, where they form the greater part of the Cliff, where they are mainly of a mottled red and grey, or pale blue colour, the general appearance being purple.

Between Fairlight undercliff and Hastings, however, this mottled character is absent, and the beds consist, to a great extent,

of pale blue — almost white sometimes —and grey sandy clays. These seem to stand out in contrast to the pale buff Ashdown Sand rock above, and to the Wadhurst Clays above them, and mark distinctly the junction with the Ashdown Sands. At the East Groyne this line lies about 12 feet or 14 feet above the Groyne, and about 30 feet from the foot of Cliff. East of the Slip, underneath the Coastguard flag-staff on the East Hill, (a point called by the quarrymen "Foulness," or Fowlness") the beds are brought down by a "fault" some 30 or 40 feet, but they gradually rise again eastward by an upheaval.

Besides the pale sandy clays, there are sand rock (generally pale), ironstone, and iron-clay-stone, but no "blue-stone," as in the beds above.

Plant remains are found plentifully scattered throughout these beds, chiefly in the form of lignite, but well-preserved leaves are only found in beds of limited extent and thickness, and are of rare occurrence.

E. C. *Photo. ad nat.*

Foot Impression of

IGUANODON.

Discovered at Fairlight, Hastings, by P. J. Rufford.

(One-Seventh nat. size.)

This specimen is in the Geological Section of the Hastings and St. Leonards Museum.

The Fairlight Clays are essentially a plant Formation, though fishes and reptiles are occasionally found; also the footprints of *Iguanodon** at various horizons, and ripple-marks.

Thickness of beds (bottom not known) 360 feet.

FORMATION No. 2.

ASHDOWN SANDS.

About 14 feet above the East Groyne, and overlaying the pale blue clays which indicate the top of the Fairlight Clays, there is a change into red buff Sandstone. For the first (lowest) 43 feet it is of rather a loose character, and apt to form steps, or slopes, in contrast to the thick perpendicular bed above, at the junction with which there is a thin parting from 12 inches to 18 inches of

* For illustration of a very fine foot impression of *Iguanodon*, secured by P. J. R. from this locality, see Plate XX.

carbonaceous loam, which allows a little vegetation to grow upon its face. There is another band of similar loam at about 13 feet from the bottom of the Ashdowns.

Above the main Sandrock bed, which occupies the centre of the Cliff, a bed of an entirely different nature may be observed, which is 12 feet thick, and consists of dark blue clays and shales, with partings of thinly-bedded sandstone, and ironstone. About the middle of the bed occurs a band, from 6 inches to 15 inches thick, of a blue calcareous stone (of inferior quality for road metalling) containing on the upper surface numerous foot-impressions of *Iguanodon.* These, in consequence of the original firmness of the bed upon which the animals walked, are not generally very distinct, the deep imprints of the toenails only being left; in some cases, however, a good impress is obtained.

Above this clay bed we reach another bed of white sand rock, of about 19 feet in thickness, and constituting the top of the Ashdown Sands.

At its base, and included in it, there occurs a bed from two feet to three feet thick, of a calcareous limestone, which is of two qualities, one (the lower) called "blue" stone, and the upper called "grey" stone. The "blue" stone is, however, often absent. This is regarded as valuable stone for road metalling, and other purposes. At the immediate base of this band there is a finely laminated layer of cream-coloured sand containing numerous remains of *Hybodus*, chiefly the fin-spines, curved head-spines, and teeth; also of Crocodile, and *Pterodactyl.* The layer might well be described as the Hybodus-layer. At the top of this sandrock bed (the 19 feet bed) there is a surface layer of oxide of iron, and ripple marks; there is also a thin band from a few inches to 12 inches thick, of black carbonaceous sand, which, by percolation, has stained the almost white sandrock below, a dark hue. This band marks the commencement of the Wadhurst Clays. The total thickness here of Ashdown Sands is about 163 feet.

FORMATION No. 3.

WADHURST CLAYS.

Near the East Groyne, the Wadhurst Clays occupy a position at the top of the Cliff, and are plainly distinguishable from the thick beds of Sandrock belonging to the Ashdown Sands below.

A thin band of carbonaceous sand, from a few inches to 12 inches in thickness, occurs at the base. The beds consist mainly of dark blue clays and shales with thin partings of sandstone, often containing "bluestone." About 10 or 15 feet above the base is a bed of dark brown or buff Sandstone, some 4 feet 6 inches in thickness, from which "bluestone" is obtained, but this latter is seldom thicker than 18 inches, and is sometimes absent. It is a calcareous sandstone, similar to that found at the base of the sandrock bed below, and is regarded as the best quality of stone obtained here for road metalling. Where the sandrock is associated with the "bluestone," the junction is generally

characterised by a curious bubble-like surface; in this bed the hemispherical forms turn downwards, whereas in the bluestone bed in the Ashdowns, the same curious formation is noticeable, but the "bubbles" turn upwards. Infiltration appears to be the cause.

Between the base of the clays and the main "blue-stone" bed, there are two or three bands of iron sandstone, and clay ironstone. Ironclay nodules also occur both below and above the main "bluestone" bed.

At "Foulness," (or "Fowlness"), the slip under the flag-staff on the East Cliff, a "fault" or fracture has brought down the beds on the north east side from 30 feet to 40 feet, showing some thickness of blue clays and shales overlying the main "bluestone" bed, and superimposed, in their turn, by 10 feet of buff sandrock, with sandy clays above. These beds on the south-west side have been levelled by denudation. The sandrock bed may be seen also at the "Gringer,"* a small gap between Ecclesbourne and Fairlight.

P. R.

*Gringer, derivative (?) *Gringotter*, Fr., to warble, in allusion to the sound of trickling water (?).

A. Gepp, Photo. ad nat.

Ruffordia Göpperti, Dunker.

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TABLE E.

Systematic Table to show the position of

Ruffordia Göpperti, (Dunker.)

IN THE

MESOZOIC PLANTS

THE WEALDEN FLORA.

GROUP—PTERIDOPHYTA.

(Vascular Cryptograms).

CLASS.—**FILICINÆ.**

SUB-CLASS.—**FILICES.**

ORDER.—LEPTOSPORANGIATÆ.

Family.—? SCHIZACEÆ.

Genus.—RUFFORDIA. gen. nov.

Ruffordia Göpperti, (Dunker.)

"These two fronds, or pinnæ, represent one end of the series of variable forms; the ultimate linear-acuminate segments are uninerved. The habit is compact, and the

pinnæ have a more or less deltoid form, with the details distinctly marked as light brown impressions on a homogeneous ironstone.

Found at Ecclesbourne. *Rufford Coll.*"

In Plate XXI. "is reproduced one of the most perfect specimens of *R. Göpperti*" representing "the form of frond which is characterized by fine and narrow ultimate segments," it is "an example of a fern much more perfectly preserved than is usual among the fossil representatives of the *Filices*."

"The adoption of the name *Ruffordia* is to place on record the enthusiasm and careful work of Mr. Rufford, to whose labours we are indebted for the material on which the genus has been founded."

"The plants included under *Ruffordia* are all referred to one species, some of the specimens being placed in a variety to denote a marked difference in size of the ultimate segments of the sterile fronds.

"The genus is characterized by a distinct contrast between barren and fertile pinnæ, by the resemblance of the pinnules to those of *Anemia adiantifolia*, Sw., and by the correspondence in habit of sterile and fertile pinnæ to that species.

"*Ruffordia* is placed in the *Schizaceæ*, but, in the absence of very satisfactory proof, with the addition of a query expressive of the imperfect evidence."

Extracts from "Catalogue of the Mesozoic Plants in the department of Geology, British Museum (Natural History), by *A. C. Seward, M.A., F.R.S., F.G.S.* Part 1, 1894.

CORRIGENDA.

Page 6, line 11, from top for *mesoglœa* read *mesoglæa.*

Page 7, line 7 from top for *mesoglœa* read *mesoglæa.*

Page 16, line 12 from top for *Specialised* read *Specialized.*

Page 27, line 14 from top for *sponges* read *Sponges.*

Page 29, line 10 from bottom for *coral polyps* read *Coral polyps.*

Page 55, line 4 from top for *Perigonimus* read *Perigoniums.*

Page 79, line 9 from top for *Hinck's* read *Hincks'.*

INDEX.